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HEAVYWEIGHT AND LIGHTWEIGHT PROCESS AUTOMATION

How do companies select between RPA and back-end automation?

Master's Thesis
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Abstract

This study provides novel insight about how companies select between lightweight and heavyweight process automation and what are the factors affecting this selection.

The automation approaches compared in this study are Robotic Process Automation (RPA) and back-end automation, defined as *invasive automation, implemented by means of system development and/or data or application layer system integration*. Decision about automation approach is not trivial, but can have a long spanning effect on company's operations.

In this study, two automation cases where selection between RPA and back-end automation was made were observed. Moreover, expert interviews were conducted in companies operating in fields of finance, telecommunications, and IT services. Based on this, four decision making criteria used by companies and eight heuristic factors that seem to indicate suitability of either approach were identified. The decision making criteria are Business case, Scope, Time to market, and Anticipated development of system architecture. The heuristic factors are Number of systems, Process volume, Changes anticipated in automation requirements, Stability of user interfaces, Interfaces between systems, Time to market, Permanence of process, and IT resource situation.

It seems that companies do not proactively consider all of the factors that affect their selection by the end of the day. Stance of this study is that by recognizing also heuristic factors mentioned above, companies can make better informed decisions that help them to reap the benefits of automation.

Keywords RPA, Lightweight IT, Heavyweight IT, Business Process Automation

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Tämä tutkimus tarjoaa uusia näkökulmia siihen, kuinka yritykset valitsevat raskaan ja kevyen prosessiautomaation välillä ja mitkä tekijät vaikuttavat tähän valintaan.

Tässä tutkimuksessa vertaillut automaatiotyökalut ovat ohjelmistorobotiikka ja back-end automaatio, joka on tässä yhteydessä määritelty automaationa, joka on toteutettu järjestelmäkehityksen ja/tai data- tai applikaatiotason integraation kautta. Päätös automaatiolähestymistavasta ei ole triviaali, vaan sillä voi olla kauaskantoisiakin vaikutuksia yrityksen toimintaan.

Tässä tutkimuksessa hyödynnettiin kahta toisiaan täydentävää tutkimusstrategiaa: case-tutkimuksia ja asiantuntijahaastatteluja. Case-tutkimuksissa havainnoitiin kaksi automaatioprojektia, joissa tehtiin valinta ohjelmistorobotiikan ja back-end automaation välillä. Tämän perusteella tunnistettiin neljä päätöksentekoriteeriä ja kahdeksan heuristista tekijää, jotka vaikuttavat lähestymistapojen sopivuuteen. Päätöksentekokriteerit ovat *Business Case*, *Time to market*, *Ratkaisun laajuus* ja *Järjestelmäarkkitehtuurin kehitys*. Lisäksi lähestymistapojen soveltuvuuteen vaikuttivat *Järjestelmien määrä*, *Prosessivolyymi*, *Automaatiovaatimuksiin odotetut muutokset*, *Käyttöliittymien stabiilius*, *Järjestelmärajapinnat*, *Time to market*, *Prosessin pysyvyys* sekä *IT-resurssitilanne*.

Vaikuttaa siltä, etteivät yritykset proaktiivisesti huomioi kaikkia tekijöitä, jotka lopulta vaikuttavat niiden päätöksentekoon. Tämän tutkimuksen kanta on, että tunnistamalla ja huomioimalla myös heuristiset tekijät yritykset voisivat tehdä valistuneempia valintoja ja saavuttaa kestävämpiä automaatiohyötyjä.

Avainsanat RPA, Prosessiautomaatio, Kevyt ja raskas IT

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1 Introduction

In this study, I shed light on how companies make selection between lightweight and heavyweight process automation. I do this by drawing from expert insights and real life cases where selection between two automation approaches, Robotic Process Automation (RPA) and back-end automation, had to be made.

RPA is a developing area of business process automation and one of the current buzzwords in the industry. RPA vendors and IT consulting companies promise productivity gains for companies going down the path of utilising *"digital workforce"*, and case studies by Lacity and Willcocks (2015) indicate that by applying RPA to routine, structured and rule-based service processes, companies can indeed achieve significant productivity gains (Lacity & Willcocks, 2016). RPA drivers include decreased delivery times, improved service quality, low error rates and process scalability (Willcocks, Lacity & Craig, 2015/06). These can be seen as general benefits of automation, but RPA promises to deliver them in a significantly fast and cost efficient way: according to case studies, RPA projects can provide ROI of 30-200% during the first year (Lhuer, 2016).

However, although new technologies are often welcomed with enthusiasm, they are not a panacea for all ills. Studies suggest that biggest benefits from RPA can be reaped when it is handled as one tool in company's process improvement toolbox, not isolated from other approaches (Forrester Consulting, 2014; Lacity, Willcocks & Craig, 2015/04, p. 11). One set of approaches is back-end automation, which I define as "*invasive automation, implemented by means of system development and/or data or application layer system integration*". Comparing RPA and back-end automation is interesting, as they are fundamentally different by their degree of invasiveness. The "traditional" automation approaches have track record and various strengths, and are in many cases more suitable solution than RPA. However, companies still lack understanding of what factors to consider when selecting between RPA and back-end automation.

The theoretical lens used in this study is the concept of heavyweight and lightweight IT developed by Bygstad (2016). In his work, Bygstad mentions RPA as an example of lightweight IT, setting it in contrast with traditional integration technologies and "mainstream IT", which he regards as heavyweight. However, Bygstad does not discuss how selection between these approaches is made. Especially in the context of process automation, factors affecting selection between heavyweight and lightweight approach remain to be explored. Therefore, looking into how companies select between

RPA and back-end automation can provide novel insights from both managerial and academic perspective.

Based on the issues mentioned above, I formulated two research questions, which are as follows:

1) *How do companies choose between lightweight (RPA) and heavyweight (back-end) process automation?*
2) *What attributes affect suitability of these approaches?*

In answering these questions, I utilised two complementing research strategies: expert interviews and case studies. Data collection for this study included two main phases. In the first phase, I conducted expert interviews in companies operating in fields of telecommunications, banking, and IT services in Finland. During the second phase, I observed two automation cases in 'Telco Oyj', where selection between RPA and back-end automation was made. By looking into decisions made by Telco Oyj and combining these insights with learning from expert interviews, I identified set of decision making criteria and indirect factors affecting selection of automation approach. It seems that companies do not proactively consider all of the factors that affect their selection by the end of the day. My stance is that companies would greatly benefit from recognising these factors and taking them into consideration in earlier phases of their decision making.

In section two, I introduce the theoretical background of this study. I discuss new challenges of business process automation and how heavyweight and lightweight IT have been suggested as approaches for tackling these challenges. I also introduce Robotic Process Automation and back-end automation, which are concrete examples of these two regimes.

In section three, I introduce methodology used in the empirical part of this study, also describing the process of data collection and analysis. In section four, I present findings that emerged during the analysis, first going through learning from expert interviews and then moving on to cases observed in Telco Oyj. In section five, I discuss these findings in light of existing literature. Finally, I present conclusions and give suggestions for further research.

2 Business process automation: heavyweight and lightweight approach

In this section, I introduce the theoretical background of this study. I start by briefly discussing business process automation: how it is increasingly about automation of IT-enabled processes, where the growing complexity of interconnected information systems poses new challenges. I also look into different approaches that have been developed for tackling these challenges: I dive deeper into concept of heavyweight and lightweight IT, which Bygstad (2016) sees as responses to the growing IT system complexity. Finally, I introduce RPA and back-end automation as concrete examples of these different approaches.

2.1 New challenges of business process automation

Today, automation of IT-enabled processes is an important and constantly developing field. Modern societies are increasingly dependent on IT-enabled solutions, and business process automation has been a way of enhancing productivity especially in back-office processes (Willcocks, Lacity & Craig, 2015/06, p.3). It has also helped to increase quality of services, improve process safety and utilise the available resources more efficiently (Mohapatra, 2009, p.1). Today, the twofold task of corporate IT is often to support company's growth while containing the costs of operations. Business process automation has central role in achieving these objectives: eliminating costly, repetitive, and error prone manual tasks with automation is often viewed as solution for corporate ills (Mohapatra, 2009, p.2).

During the past few years, business process automation has been increasingly entering the territory of knowledge work and front office processes. This development has been driven by emerging technologies like Robotic Process Automation. The trend itself is not new: in fact, it can be viewed to have started latest in the 1990s. A fundamental example are Enterprise Resource Planning (ERP) systems, which have helped companies to streamline their labour intensive processes, like payroll or inventory management. In the 90's ERP-systems were recognised as the most important development in corporate use of information technology (Watson & Holmes, 2009, p. 1602), and they were even predicted to be the end of white collar jobs:

> *"Most white collar jobs – as we know them – will disappear as we get the ERP/Enterprise Resource Planning – etc. – 'stuff' right."*
> *Peters (1999, p.3): The Project 50 (Reinventing Work)*

As we have witnessed since then, ERP-systems have not completely replaced white collar jobs. However, the interplay of automation and knowledge work remains a timely and interesting question. Davenport (2013, p. 46) wrote about the different role of automation in industrial and knowledge work:

> *"[In industrial work], productivity increases by automating tasks and speeding up work flow. Automation enables machines to take over more and more of the tasks we do. Machines replace workers. --*
> *[In knowledge work], productivity increases by increasing communication and integrating work. Automation enables and facilitates work; it does not take over."*

Today, the above statement about different roles of automation in industrial and knowledge work can be questioned. Knowledge work can comprise of wide set of tasks ranging across the skill spectrum (Autor, 2015, p.26). Thus, it often includes certain *tasks* that are repetitive, rule based and mundane, such as transferring data from one information system to another. Due to new technologies like Robotic Process Automation, these tasks are increasingly susceptible to automation. As automation moves increasingly to the territory of knowledge work, the relevant question is therefore not which occupations will be automated, but which *tasks* or *activities* in these occupations will be automated (OECD, Automation and Independent Work in a Digital Economy, 2016; Chui, Manyika & Miremadi, 2015). McKinsey report states that although only 5% of occupations could be automated completely, *"about 60% of occupations could have 30% or more of their constituent activities automated"* (Chui, Manyika & Miremadi, 2015). Also OECD (2016) views that many jobs will be radically transformed due to this development.

While new technologies enable addressing processes that used to be outside the range of automation, they are not a panacea for all ills. To maximise benefits of automation, companies must understand characteristics of different technologies and consider carefully which tool to utilise in each case. Mohapatra (2009, p.7) lists things that

should be considered when applying automation to a process. These include *choosing the technically most suitable implementation,* which takes into account also changes and roll-outs that can be anticipated in the future. Chosen solution must cater to current business needs, but also upgrading or replacing it according to changes in the business environment must be possible. Moreover, automation should *ensure quality and cost-effectivenes* while being aligned with the business objectives. Automation techniques vary by their setup and running costs and features, and long term effects of all of these should be considered. To set up cost-effective automation that serves the business need without compromising quality, companies must understand exact requirements of automation and needs of business. Finally, Mohapatra states that *measurable metrics* about the process performance should be available: this is needed for analysing the system before and after automation and fine-tuning the automation in the future (Mohapatra, 2009).

Whichever the chosen automation approach, companies seek for similar kinds of benefits. According to Fung (2014, p.6), benefits of IT process automation include IT service predictability, IT service re-usability, better IT integration of services, increased IT service productivity, reduced IT service risk, IT service cost effectiveness and improved business performance. Also Mohapatra (p.28) lists business benefits of consolidating processes with business process automation. These include reduced costs associated to additional applications, simpler interactions with services, enhanced synergies and data sharing between business groups, generating metrics on process performance, and IT staff using less time in providing, maintaining and supporting numerous applications. No wonder automation often seems like a tempting solution for increasing business profitability.

However, there are obstacles on companies' way towards reaping gains of automation. One of the major challenges is the increasing complexity of IT systems. Modern societies have become heavily dependent on large and complex IT systems, their key characteristic being that they consist of various independent systems that are integrated and orchestrated. These are called "Systems of Systems" or SoS (Sommerville et al., 2012). Related to Systems of Systems, Sommerville et al. identify two different types of complexity. The first type is *inherent* complexity, which depends on number and nature of relationships between elements, and it is exposed only in dynamic operation of the system. The second is *epistemic* complexity, which stems from our lack of understanding about the system.

In general, system complexity depends on various factors. First is the *number of relationships*, both between system components and between the system and its environment (Sommerville et al., 2012, p.3). These components can be either social or technical, and their interactions are typically socio-technical (Bygstad et al., 2015). Second factor is the *type of relationships* (Sommerville et al., 2012, p.3). Another thing increasing system complexity is the number of *interdependencies*: when state of one component depends from the state of another, change management becomes increasingly important. Also, the *rate of change* affects system complexity: understanding and governing a system becomes more challenging as the speed of change increases (Bygstad et al., 2015). Increasing complexity and scale of information systems pose new risks and challenges to software development (Sommerville et al., 2012).

Bygstad (2016) views that one reason for emergence of complex Systems of Systems is attempt to integrate silo systems. According to de Bri et al. (2010, p.122), silo systems are like an IT implementation of the Weber's theory of bureaucracy: they focus on serving certain vertical segment or need, as they have originally risen from organisational hierarchies and functional organisation of labour. As a result of poor coordination between silo activities, problems like inconsistent and replicated data and work emerge (de Bri et al., 2010). As operations of many organisations have since changed from functional orientation to process orientation and interaction between departments, in many cases silo systems have become liability (Bygstad, Hanseth & Le, 2015).

As silos have become somewhat problematic, multiple approaches have been suggested to break them up. Bygstad et al. (2015) list at least Process thinking, Standards and interoperability, the "ERP" solution, Enterprise Architecture (EA), Service Oriented Architecture (SOA), Data Warehouse, and Centralised Governance as means used for this purpose. In addition to these approaches, a new and more business object oriented way of thinking about IT strategy has been suggested by academics (de Bri, Bannister & Remenyi, 2010; Bharadwaj, El Sawy, Pavlou & Venkatraman, 2013). Bharadwaj et al. (2013) are advocates of rethinking the role of IT strategy. In the past decades, they argue, companies' business strategies have typically been guiding their IT-strategies. According to this thinking, IT strategy is always subordinate to business strategy and must be aligned with it. However, as modern business infrastructure is increasingly digital and business processes have become increasingly dependent on IT services, Bharadwaj et al. (2013) argue that role of IT strategy should be rethought from a function-level strategy to one that reflects

fusion between business and IT. This is what they call *digital business strategy* (Bharadwaj et al., 2013).

To conclude, business process automation is increasingly important and moving also to the domain of knowledge work. However, there are also challenges, one of them being increased complexity of IT systems. This stems partly from the wish to integrate silo systems, which are a common liability in organisation. The problems caused by complexity can be tackled with different business process automation approaches: in this study, I draw from the concept of *heavyweight and lightweight IT* (Bygstad 2016). Next, I give an overview of the concept of heavyweight and lightweight IT and their neighbouring concepts.

2.2 Heavyweight and lightweight IT

The concept of heavyweight and lightweight IT was developed by Bygstad (2016), who suggested these terms for dealing with two trends in IT industry. The first trend he identifies is the *growing size and interconnectivity of IT systems*, partly driven by attempt to integrate IT silo systems. With integrations, companies can try to reduce complexity, lack of agility, and hindrance for innovation that are caused by silo systems. The second trend is *consumerisation,* a development which challenges the hegemony of IT departments with trends such as 'bring your own device' –model and technologies bypassing the IT departments (Bygstad, 2016, p. 1-2). This, Bygstad believes, is a response to bureaucratic solutions and mechanisms of company IT. Thus, Bygstad views both of these trends as responses to growing complexity of IT solutions. Next, I'll introduce the differences of heavyweight and lightweight IT as described by Bygstad.

2.2.1 Differences of heavyweight and lightweight

Bygstad views heavyweight and lightweight IT not merely as different technological approaches, but two different knowledge regimes. Knowledge regime in this context means unity that includes network of actors (such as users, vendors and IT professionals), work practices, technologies and the shared knowledge. Heavyweight IT presents more or less the "traditional" or "mainstream" IT delivery, whereas lightweight IT is characterised by business orientation, quick experimentation, and user driven solutions bypassing IT departments and utilising easily available technologies (Bygstad, 2016). Another key

difference in lightweight and heavyweight IT is the *degree of their invasiveness*. Lightweight solutions often use the presentation layer and don't change the underlying architectures, whereas heavyweight solutions act on the data access or business logic layers (Willcocks, Lacity & Craig, 2015/05). I highlight this notion, as it becomes essential later when we look into RPA and back-end automation, which present examples of lightweight and heavyweight IT.

Bygstad defines heavyweight IT as well-established knowledge regime that is associated to development and maintenance of large systems. Profile of heavyweight IT systems is typically back-end, transactional and supporting the documentation of work. In heavyweight IT, more sophisticated solutions are developed through complex integration. Therefore, it's core territory of IT professionals and proven technologies: back-end integration typically requires software engineering and utilising solutions like ERP, SOA or enterprise service bus. Heavyweight IT is a mature field, and it has a systematic development culture that concentrates heavily on quality and security.

Despite its established nature, heavyweight IT has its own challenges. Like Sommerville et al. (2012) point out, growing scale and integration that are characteristic for heavyweight IT lead to increasing costs and complexity. Moreover, in many organisations heavyweight IT (typically meaning company IT) is facing more requests than it can fulfil, which leads to growing IT development backlogs (Bygstad, 2016; Willcocks, Lacity & Craig, 2015).

On the contrast, lightweight IT is what Bygstad defines as the "new" knowledge regime that is closely related to consumerisation of IT and Internet of things. The profile of lightweight IT is typically front-end applications that support processes. Also, its essential feature is that its deployment often bypasses IT departments: development relies more on competent non-IT users and vendors, who can create simple, specialised applications to support work. Cheaper, more available and easy to use technology is in the core of lightweight IT: lower cost and accessible technologies offer non-specialists new experimenting possibilities. In a sense, lightweight IT can act as an "innovation arena" (Bygstad, 2016, p.1-2). However, also lightweight IT has its problems: lightweight solutions can lead to disconnected applications and gadgets, and also privacy and security issues can be harder to address with lightweight technologies.

Bygstad's lens for comparing lightweight and heavyweight IT is generativity. This means the technology's adaptability and capacity to produce new innovative combinations

and solutions. He looks into three generative mechanisms that reinforce each other and work differently in heavyweight and lightweight IT: *innovation, adoption,* and *scaling*. In heavyweight IT, *innovations* typically arise from the interactions between IT specialists, possibly involving business managers. Users are mostly represented in written requirements or as interface co-designers. In contrast, lightweight IT innovations tend to develop from interactions of powerful users and IT specialists, combining specific tasks with standardised technology. Also *adoption* of heavyweight and lightweight technologies is different: adoption of heavyweight IT is often mandatory and follows a waterfall model, whereas adoption of lightweight IT is typically voluntary and more improvised. Lastly, the ease of *scaling* heavyweight IT depends on the architecture, but scaling lightweight IT tends to be difficult, as it can be tailor made and dependent on dedicated individuals (Bygstad, 2016, p.9-10).

Bygstad suggests that the greatest benefits from heavyweight and lightweight can be achieved through their interaction. He argues that *"it is their interaction that represents the real generative potential"* (2016, p.10), which also means that lightweight IT in itself should not be romanticised. Although lightweight approach might be more appealing in certain cases, it is not a panacea for all IT problems.

To realise the generative potential of these two regimes, Bygstad suggests *loose coupling*. This means *interaction* instead of integration: integration allows seamless co-operation, but also increases interdependencies that might increase complexity while reducing agility (Bygstad, 2016, p.11). Bygstad also recommends not applying the governance principles of heavyweight IT to lightweight IT too early. He argues that heavyweight IT is already overloaded, and sensible division of labour between heavyweight and lightweight is more beneficial. Additionally, strict governance might hinder the innovation processes related to lightweight IT (Bygstad, 2016, p. 12). In this case, Willcocks et al. (The IT Function and Robotic Process Automation, 2015) disagree, suggesting that same government principles should be applied in lightweight IT to avoid so called "shadow IT" or "rogue IT". Lastly, Bygstad suggests loose coupling in terms of organisation. He claims that heavyweight culture is not well suited for offering lightweight services, and claims innovation is best served if companies have different organisations for developing heavyweight and lightweight IT (Bygstad, 2016, p.11).

The concept of heavyweight and lightweight IT has a lot in common with various other concepts. In the following, I will briefly introduce some related models and also discuss the critique presented towards dichotomy of IT.

2.2.2 Context and critique

It should be noted that discussion about dichotomy between different modes of IT is not new. Legacy versus emergent systems, brownfield versus greenfield deployments or sustaining versus disruptive technologies have been discussed "since the dawn of IT", as Bloomberg (2015) puts it. Already Truex et al. (1999) discussed legacy versus emergent IT organisations, stating that new practices for IT support are needed when organisations develop from stable to emergent under economic pressures. Also Bower & Christensen (1995) advised companies in Harvard Business Review to build their disruptive technology –business in a separate organisation, away from the burdening demands of mainstream organisation. Therefore, the concept of heavyweight and lightweight IT should be regarded as an updated version of a discussion that has been ongoing for decades.

Also during the recent years, other concepts with similar features have been presented. Most obvious example is the concept of *bimodal IT* by Gartner. Concept was introduced late 2013, and has since then been analysed by Horlach et al. (2016; 2017) in two articles. Horlach et al. identified and analysed 178 documents dealing with bimodal IT, vast majority of which (169) were published after Gartner's release. Based on their review, the only academic publication referring to the model is the one by Bygstad (Horlach et al., 2016, p.1421). Bimodal IT has risen both interest and critique, but I will describe it shortly to give an overview of the current discussion.

Bimodal IT –model suggests splitting IT organisation into two separate but coherent styles of working. These are named Mode 1 and Mode 2, which both serve different purposes. Mode 2 (also called "digital IT" or "agile IT") is suited for agile experimentation and creation of new services. The focus of Mode 2 is on innovation, exploration and managing uncertainties: therefore, it includes capabilities like agile, lean startup, adaptive sourcing and DevOps. Mode 2 systems are typically market-facing "systems of engagement", which are often low risk, low cost and non-critical. In Mode 2, IT can act as a start-up within the enterprise (Gartner, 2017; Mingay & Mesaglio, 2016). As we can see, Mode 2 seems to have many similarities with the concept of lightweight IT, for example due to its emphasis on user driven innovation, front-end solutions and agility of development.

Mode 1 (also named the "core IT", "industrial IT" or "traditional IT"), on the other hand, serves predictability, security, efficiency and reliability. These goals are driven with specialized metrics. Mode 1 focuses on the areas that are well-known and understood, and it typically supports mature core systems of organisations. Information systems associated with Mode 1 are typically mission- or business-critical and constantly running. Here, the business is less actively involved tino application lifecycle. Silos are typical in Mode 1 development, testing and operations (Gartner, 2017; Horlach et al., 2016; Horlach et al., 2017). Mode 1 can be seen as comparable to heavyweight IT.

In general, Bimodal IT is proposed as means to achieve closer integration of business and IT (Horlach et al., 2017). IT is becoming central factor in creating value in the digital age, and bimodal IT proposes convergence of business and IT. However, companies must decide whether bimodal is merely a transitional state towards fully agile IT, or a permanent way of organising their IT (Horlach et al., 2017).

Critique has been presented towards the bimodal IT -model for the strong dichotomy it suggests between the two modes. It is criticised for creating new organisational silos instead of truly facilitating convergence of business and IT (Horlach et al., 2016). Also, some argue that dividing IT into "cool" Mode 2 IT and "uncool" traditional core IT can create tension and battle for resources between the two IT teams (Golden, 2015; Horlach et al., 2016, p.1424). Moreover, it must be noted that although Bygstad (2016, p.11) states that heavyweight culture is not suited for offering lightweight solutions, he doesn't comment the opposite - possibility of offering "core IT" services in a lightweight manner. It has been argued that although heavyweight methods might not suit for innovation, this doesn't imply the opposite: that is, that agile methods couldn't be used for anything from mainframe to embedded systems (Humble, 2016). Also, this kind of simple dichotomy leaves world rather black and white. Bygstad (2016, p.3) reminds that world is not quite this simple, and heavyweight and lightweight IT are merely *ideal types*: in many cases systems have characteristics of both. Also, the two are very much interdependent and cannot exist without each other.

Table 1: Heavyweight and Lightweight IT, adapted after Bygstad (2016) and Horlach et al. (2016; 2017)

Feature	Heavyweight IT (Mode 1, Core IT)	Lightweight IT (Mode 2, Agile IT)
Type of systems	Back-end, mission- or business critical	Front-end/ Market-facing, non-critical
Technology	Mature, proven	Emergent, spontaneously adopted
Culture	Software engineering	Business and process improvement
Focus	Security, efficiency, reliability	Agility, innovation, speed
Application area	Well understood and known services	Un-known, development of new services
Invasiveness	Invasive, data-access and business logic layer	Non-invasive, presentation layer
Problems	High complexity and costs of systems	Isolated systems, privacy and security issues

Lightweight and heavyweight IT and bimodal IT are different lenses for observing similar phenomena. Combining the models of Bygstad and Horlach, I describe the characteristics of two IT approaches in Table 1. The model of heavyweight and lightweight IT undoubtedly requires further research, and the dichotomy of IT approaches has been discussed various times. Despite this, I view heavyweight and lightweight IT as useful framework in categorising approaches to business process automation. Lightweight IT describes especially well characteristics of a certain emerging automation approach, namely Robotic Process Automation. RPA offers a new alternative for back-end automation approaches that typically fit to Bygstad's description of heavyweight IT. Next, I introduce back-end automation and RPA before exploring selection between them in the empirical part of this study.

2.3 Back-end automation and RPA

In this study, I look into automation of IT-enabled business processes, concentrating on two different approaches: *back-end automation* and *RPA*. In the context of this study, I define back-end automation as *invasive automation, implemented by means of system development and/or data or application layer system integration.*

Automation typically requires either system development or integration of disconnected systems, or both. Forrester Consulting (2011) classifies levels of integration to *data layer, application layer, and presentation layer integration*. The main difference of presentation layer integration compared to the others is that it reuses existing system functionalities, whereas first two require changing the system logic or interfaces. Presentation layer integration is independent of the underlying architectural approach: no matter is the system developed with Java or COBOL, user interface already enables accessing the underlying data. While data and application layer integration are more scalable and efficient, they require higher technology sophistication (Forrester Consulting, 2011, p.7). This is the case with back-end automation: it requires specialized knowledge and skills on the field of IT and is invasive, thus being an example of heavyweight IT. In contrast, Robotic Process Automation operates mainly using presentation layer and already existing functionalities of applications and can be viewed as prime example of lightweight IT. Next, I give an overview of these approaches.

2.3.1 Back-end automation

According to Mohapatra (2009), there are four basic ways of implementing business process automation. These are 1) extending the current system, 2) purchasing a BPM-solution with BPA extension, 3) purchasing a middleware solution, or 4) using special purpose built-in tool. At least the first three fall to the category of back-end automation.

By *extending the current system*, companies can sometimes sufficiently respond to the new business needs. This means extending the features of already existing system, typically by means of system development. Extending the current system can be sufficient when automation is done in process using one system.

Purchasing a Business Process Management solution with BPA extension is the other approach Mohapatra lists. He sees that developing automation on a BPM solution is feasible, although the two are distinctively different. However, this approach can be time

consuming, as although BPM provides a framework for mapping all business processes, this delays automation of individual processes.

Third alternative is *purchasing a middleware solution*. The term middleware is used to describe solutions that are used to connect two or more already existing programs. They are a central element of IT infrastructures, as they allow joining heterogenous systems together in one framework. This is done by routing data between databases and end user applications (Mohapatra, 2009). Multiple middleware approaches have been developed, one of the newer ones being Enterprise Application Integration (EAI), which provides an integration framework for combining a set of technologies (Sabooniha et al., 2012). Serrano, Hernantes & Gallardo (2014) offer a comparison of solutions for EAI. They group these solutions from lightest to heaviest as follows: *Integration framework* (libraries implementing APIs), *Enterprise Service Bus* (frame and deployment, administration and monitoring tools), and *Integration suite* (ESB and business specific tools like BPM). The most suitable approach depends on complexity and requirements.

The last approach Mohapatra mentions is *acquiring special purpose built-in tool*. He sees these as shortcuts to automation, as they are built specifically for business process automation, and can often be used also by non-technical users due to simple user interfaces. However, they also add a new software provider into the equation. Some of these tools probably fall under category of back-end automation, but using Robotic Process Automation platforms can be seen as on example. Next, I will introduce RPA.

2.3.2 Robotic Process Automation

Robotic Process Automation is an emerging field of business process automation. It differs profoundly from back-end automation approaches in the aspect that it utilises the existing features and user interfaces of already existing systems. No underlying systems programming logic needs to be changed, as systems are accessed through presentation layer (Willcocks, Lacity & Craig, 2015/05). In RPA, applications called 'software robots' are configured to interact with information systems, replicating the actions of human workers. This is why software robots are sometimes referred to as 'digital workforce'. Like was concluded by CGI (3.2.2017):

> *"Big part of the work has already been digitised – now we are digitising the worker."*

In RPA terminology, a "robot" is basically equivalent to a software license. Different tools and practices exist for configuring robots to perform the wished processes: these include recording workflows, using graphical interfaces with process flowcharts where elements can be dragged, dropped and linked, or using scripting language (Willcocks et al., 2015/05; Annala, 21.3.2017). Process libraries can be created out of the modelled process elements which contain detailed step-by-step instructions that robots follow (Penttinen & Asatiani, 2016). This way, elements used in multiple processes, like logging in to a certain system, can be reused and updated more easily.

As RPA is a software based solution, the limitations for automatable processes are that their inputs must be in a digital and structured format and the process must be rules based. Software robots can for example move and click the mouse, interpret text and pictures on screen, and copy, paste and write characters. RPA is technology independent, and robots can use any applications and sources from mainframe to Excel and from CRM or ERP to web applications (Willcocks, Lacity & Craig, 2015/06). Other lightweight solutions, like macros and scripting, have existed already for long. However, RPA can be seen to present evolutions from these basic solutions, as enterprise RPA platforms allow defining a lot richer logic and support more complex processes. Compared to these solutions, the most notable potential of RPA lies in automating processes that are deeper in the traditional domain of knowledge workers (Barnett, 2015). In the report of research and consulting company Ovum, Barnett states that RPA represents evolution of automation technology in two different domains: automation of IT-centric processes and automation of business-centric processes. The first are typically found in IT help-desk, whereas the other often locate in customer call centres. According to him, the convergence of these two approaches in RPA leads into 'agnostic' process automation, *"where the key aspect will be knowledge capture and the automation engine, as well as the capture, scheduling, and execution of tasks"* (Barnett, 2015, p.8).

RPA has various benefits. First of all, it is a relatively cost effective method of process automation: as automation can be implemented in a short timeframe (usually weeks or maximum few months) and reaping the automation benefits starts early, RPA enables automating processes which have previously been 'out of reach' and un-economic to address (Barnett, 2015; BluePrism, 2015). Typically, the costs of a software robot are between 0.1-0.19 of an in-house FTE and between 0.33-0.5 of an offshore FTE (Penttinen & Asatiani, 2016). Moreover, it has been claimed that RPA software with it's graphical

interface is designed for non-programmers and advanced IT skills are not needed in robotising processes (Willcocks, Lacity & Craig, 2015/05). This would enable business users to create quick solutions themselves: IT resources are often tied to more critical tasks than process efficiency improvements, and RPA could thus drive operational agility and allow reacting quickly to changing business needs (Forrester Consulting, 2011). Examples of situations where this type of quick 'pontoon bridge' –solution could be useful include sudden changes in business environment, or business users wishing to make simple extensions to existing applications (Forrester Consulting, 2011, 2014). Willcocks, Lacity & Craig (2015/06, p.19) view that especially after RPA has been institutionalised in company's operations, it could be utilised in testing new business strategies cheaply and quickly. Last but not least, as RPA is non-invasive by nature, it enables connecting systems where interfaces are hard or impossible to build: for example, creating interfaces to legacy applications, where a costly and difficult surgery by software developers would otherwise be needed. These interfaces can in turn be used for example in BPM solutions (Barnett, 2015).

However, RPA has also limitations. Although software robots outperform humans on speed and quality and make no errors, they cannot work faster than the overall process allows them to. Although robots could theoretically be working 24/7, the existing processes can considerably limit the effective time (Willcocks, Lacity & Craig, 2015/06). Also, although RPA is claimed to be business driven, IT still has an important role in setting up the facilities: this includes access rights, maintaining process logs, and setting up virtual resource agents. Encryption might be needed when robots use the existing network infrastructure to access the existing applications (Forrester Consulting, 2014). Maybe most importantly, RPA is inferior to back-end automation when it comes to performance: RPA is not optimal for handling the heaviest transaction masses, and currently it's mostly a temporary solution bridging the gap between large scale system development and running manual processes on legacy systems (Penttinen & Asatiani, 2016).

2.3.3 Which road to follow

As seen above, RPA and back-end automation are rather different approaches to business process automation. One way to frame the differences of RPA and back-end automation is the concept of long tail of automation. Long Tail model was originally introduced by Anderson (2004), and in RPA-contexts it's used to describe how RPA extends the range of automatable processes. In its original context, The Long Tail is about the focus of

economy shifting from a relatively small number of "hit products" (the head of the demand curve) into a vast amount of niches (the long tail). This shift is made possible especially by digital goods and online marketplaces that reduce costs of production and distribution. When 'economics of scarcity' doesn't limit offering into hits and consumers have practically infinite choice, true shape of the demand curve is revealed (Anderson, 2004). What makes the Long Tail truly significant is its size: Anderson estimates that by serving the demand in the Long Tail, companies can more than double the market they operate in.

Since then, the Long Tail model has been adopted by RPA vendors to illustrate how RPA changes the economics of automation and enables addressing the Long Tail of companies processes (see Figure 1). The key is that companies have a small number of high value and highly specialised processes, and a long tail of lower value and more generalised processes. On the left side of the figure, we have the head of the curve with high volume processes where automation is already applied, typically with specialised systems like ERP, CRM, and SCM: this is so called "core IT". After the head of the curve, we have processes where automation needs have been addressed with solutions like BPM. In both cases, acquiring, modifying and replacing automation solutions requires specialised IT capabilities. However, Forrester Consulting (2011) claims in their paper commissioned by Blue Prism that over half of the automation potential remains unaddressed. These processes form the Long Tail of Automation, and they could be addressed with RPA.

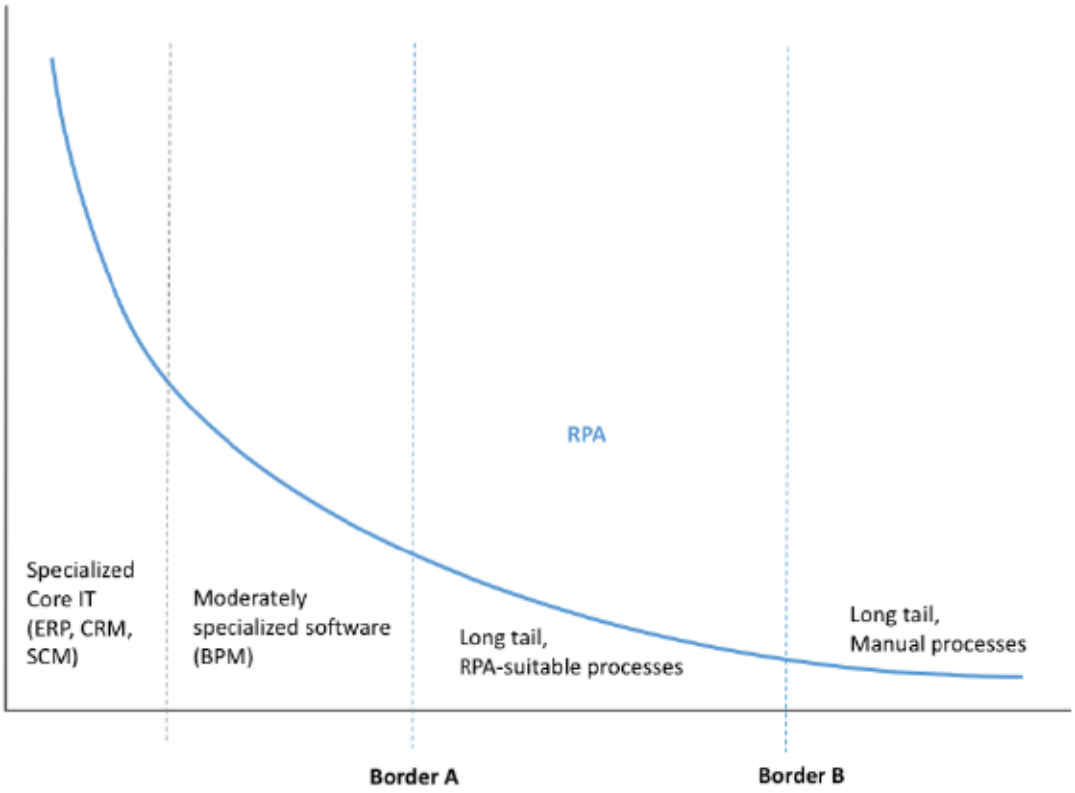

Figure 1. New borders in Long Tail of Automation

As RPA pushes the border of automation further down the long tail, two frontiers emerge: *border A* between RPA and the so called "traditional IT" or "back-end automation", and *border B* between RPA and manual processes. While border B has been already discussed (e.g. Penttinen & Asatiani, 2016; Lacity, Willcocks & Craig, 2015/04) and frameworks for identifying manual processes with RPA potential have been developed by consulting companies (eg. Accenture, 2016), border A remains less explored. In border A, we face the question of what processes should be automated using back-end automation, and where RPA could offer a better solution. In this study, I shed light on how companies make this decision and what factors affect their selection. In section 3, I introduce the methods and data used in the empirical part of this study.

3 Methodology

3.1 Approach of the study

The questions that I searched to answer in this study are:

1) *How do companies choose between lightweight and heavyweight process automation?*
2) *What attributes affect suitability of these approaches?*

More specifically, I looked into selection between a specific lightweight approach, Robotic Process Automation, and back-end automation, which can be generally considered as more heavyweight approach. In the existing research (eg. Lacity, Willcocks & Craig, 2015/04; Penttinen & Asatiani, 2016), attributes of RPA-suitable processes have been identified. However, stance of this study is that many of these attributes (like easy decomposition into rules, proneness to human error) describe general automation potential of the process: selection between different automation approaches has not been sufficiently researched. To provide companies better basis for decision making, it's important to understand both the currently used decision making criteria and more fine grained factors affecting suitability of automation approaches.

I approached the questions with a *qualitative* study using mostly an *inductive* stance. In inductive approach, the theory and concepts emerge from data, rather than the other way around (Yin, 2011, p.93). RPA is a relatively new field of process automation, and not much academic research yet exists about the topic. With a little explored topic like this, inductive stance can help to lay the groundwork for future research. Also, as many companies are only setting up their RPA operating models, getting sufficient amount of quantitative information about decision making criteria was unlikely. Thus, I approached the questions with a qualitative study.

To examine the questions from multiple angles, I combined two research strategies: *expert interviews* and *case studies*. In expert interviews, the purpose was to inductively identify set of decision making criteria and factors affecting selection between automation approaches. After this, by observing decision making process in two automation cases in Telco Oyj, I could get detailed real life data about factors that affected selection. With this

two-fold approach, I gained more versatile insights for answering the research questions of this study.

3.1.1 Expert Interviews

The expert interviews were conducted in a semi-structured manner. Longhurst (2003) defines semi-structured interviews as a verbal interchange which is conversational yet still self-conscious, orderly and partially structured. In a semi-structured interview, the interviewer asks questions from the interviewee to abstract information about certain topic using a predefined structure. Although the interview has certain predetermined frames, it allows also flexibility: issues brought up by the informant can also be addressed. Interviewees can therefore influence the focus of the interview by bringing up issues they hold important. Semi-structured interviews can be conducted using various media. They can be arranged in person, via phone or online using video conferencing services such as Skype (Longhurst, 2003). In this research, all of these media were used for the interviews.

To find out how do companies make selection between automation approaches, several viewpoints had to be covered. The assumption was that as RPA is a new tool in many companies, mostly high level factors (like business case) would be mentioned if informants were asked directly about their decision making criteria. Therefore, more fine grained factors that in reality affect the selection were uncovered by discussing also relationship of back-end automation and RPA, strengths and weaknesses of RPA compared to back-end automation, and typical cases where RPA is experienced to shine. Decision making criteria were also discussed directly, but as assumed, informants could name mainly high level criteria when question was set in this manner. General interview templates can be found from Attachments C and D.

3.1.2 Case studies

Case studies are means of studying a certain phenomenon in a real life context. They are a preferred approach especially when posing ”How” or ”Why” –questions and when studying contemporaty phenomenon (Yin, 2011, p.17; Yin, 2003, p.1). Therefore, the approach was very much suitable for this research. The evidence for case studies can come from various sources, including interviews, observations, documents, archival records, and physical artifacts. Important principles include using multiple sources of evidence, as well as having a clear chain of evidence between the collected data and conclusions made (Yin, 2003, p.83).

For this study, I observed two cases where RPA was applied. In both cases, RPA and back-end automation were considered as alternatives. Interviews were important source of evidence, complemented by document analysis and observation made during the data collection period: this included participating to RPA project meetings, email discussions, and other informal discussions face to face. For both cases, I described the process before and after implementing RPA and discussed the factors that affeced to selection of RPA. This setup can be viewed as multiple case design with some modifications: according to Yin (2003, p.47), each case in multiple case design should be selected so that it predicts either similar results, or contrasting results due to predictable reasons. In this case, the purpose was to explore the range of factors affecting companies' decisions: calling results contrasting wouldn't be exactly accurate, although the selected cases were different by nature and provided also different insights.

In the following, I discuss the data selection criteria applied for interviews and cases.

3.2 Data selection

The expert interviews were conducted in four different companies: a Finnish financial group ('FinBank Oy'), a Finnish telecommunications company ('Telco Oyj'), and two service providers (CGI and Digital Workforce). The case studies were done about Telco Oyj's processes.

Several factors affected selection of this data set. RPA is an industry agnostic technology, and it has been applied in industries such as banking, insurance, digital retail, telecommunications, and healthcare (BluePrism, 2017). To find a generalizable set of factors that affect companies' selection between RPA and back-end automation, getting data from different industries was preferable. By the time of writing this, RPA has been in the Finnish market for about three years (Jari Annala, Digital Workforce, 21.3.2017), and not many companies have yet established decision making models around it. However, FinBank Oy has used software robots for over a year, and RPA is now an integral part of their process development toolbox (Jukka Sulmio, FinBank, 17.2.2017). Telco Oyj, on the other hand, is setting up it's RPA operations, and decisions made in the beginning of company's RPA journey provided a different perspective. To complement data from Telco Oyj and FinBank Oy, I interviewed also experts from CGI and Digital Workforce. Both

companies offer services related to Robotic Process Automation and have experience of RPA projects in various industries.

By the time of conducting this study, I had good access to Telco Oyj due to having a position in the company. Also, during the first phase of data collection (see Table 2), which was identifying the cases and informants, I used snowball sampling for identifying relevant informants. In this preliminary phase, snowball sampling was useful and served the purpose of finding relevant data from various industries. Next, I describe the data in more detail.

3.3 Data collection and analysis

The data was collected over a period of three months during spring 2017. Data collection included three main phases, which are described in Table 2. First phase included unofficial discussions and interviews with Telco Oyj, FinBank Oy and CGI, during which I identified potential informants and RPA projects for the expert interviews and case studies. Findings were recorded in notes and email discussions, and they served in planning the main data collection rounds.

Next two phases covered the main data collection for the study. Second phase included expert interviews with the identified informants in Telco Oyj, FinBank Oy, CGI and Digital Workforce. The final phase was data collection for Telco Oyj case studies, where interviews, documentation and observations were combined to bring in-depth understanding about the processes and decisions. All interviews in Phase 2 and 3 were recorded and transcribed for analysis.

Next phase was analysing the transcribed data. The process was iterative, but analysis was done in three main phases: creating an initial coding scheme, applying and developing the coding scheme, and analysis of the coded material. In the first phase, I went through the whole transcribed material and identified recurring themes from each interview. Having identified these initial themes, I combined them into an initial coding scheme that could be applied to material.

In the second phase, transcribed material was imported to Atlas.ti, a software for qualitative analysis of textual, graphical, audio and video data. In Atlas.ti, I coded the material using the scheme created in previous phase. More codes came up during the process and some were combined and modified. After first round of coding, I started iterating the process, looking for connections that appeared during the coding: for example,

if two codes appeared together 70% of the time, conclusion was that they should be combined or were tightly linked on a conceptual level. The final coding scheme can be found in Appendix B.

As a result, I could identify decision making criteria and factors affecting companies' selection between RPA and back-end automation. During the process of analysing data and constructing coherent picture of observed cases, I gained the insights I will introduce in section 4.

Table 2: Data collection phases

Data collection phase	Method	Length (min)	Company	Informant(s)	Outcome
1. IDENTIFYING CASES AND INFORMANTS	Informal discussion	50	Telco Oyj	Head of Department	Identified potential cases and informants in Telco Oyj
	Informal discussion	55	Telco Oyj	Solution Area Architect Channel Developer	Identified Case 2: EntertainED
	Informal discussion	240	CGI, FinBank Oy, Telco Oyj	Various attendants	Identified informants in FinBank Oy and CGI
	Informal discussion	60	Telco Oyj	Various attendants	Status of Telco Oyj RPA pilots
2. EXPERT INTERVIEWS	Interview	26	FinBank Oy	Jukka Sulmio, Program Director	FinBank's RPA learnings
	Interview	56	CGI	Petri Penttinen, VP Consulting Services, CGI Next Tuomo Pursiainen, Senior Consult	CGI's RPA learnings: RPA vs. back-end automation
	Interview	59	Digital Workforce	Jari Annala, Senior Strategy Advisor	DW's RPA learnings: RPA vs.

					back-end automation
	Interview	41	FinBank Oy	Antero Immonen, Manager, Process Development and Technologies	FinBank's RPA learnings: RPA vs. back-end automation
	Interview	23	Telco Oyj	Lari Laine, Service Manager, Company IT	Comparison of RPA and back-end in potential RPA case
3. CASE INTERVIEWS AND CASE MATERIAL COLLECTION	Interview	57	Telco Oyj	Tuija Peltonen, Service Specialist, Carrier Services	Case 1: Carrier Services
	Interview	30	Telco Oyj	Miika Hirvonen, Service Manager, Order Handling	Case 2: EntertainED
	Interview	32	Telco Oyj	Tuija Peltonen, Service Specialist, Carrier Services	Case 1: Carrier Services - Clarification
	Interview	16	Telco Oyj	Miika Hirvonen, Service Manager, Order Handling	Case 2: EntertainED - Clarification
	Documents	N/A	Telco Oyj	Access to RPA project documentation, process documentation, and other material	In-depth information about RPA cases
	Observation	N/A	Telco Oyj	Participating to meetings, informal discussions, emails	In-depth information about RPA cases

4 Findings

In the following, I introduce findings that emerged during the analysis. This section has two parts: general findings and findings from case studies.

In section 4.1, I go through topics covered in the expert interviews and present general findings that emerged from these discussions. In the end of section 4.1, these findings are compressed into a table of identified decision making criteria and factors affecting companies' selection between automation approaches. These form the first level of my findings.

After general findings I move to section 4.2, where I introduce two automation cases observed in Telco Oyj. In both cases, selection between RPA and other automation technologies was made, and I identify the factors that affected Telco Oyj's decision making. By comparing observations from real life automation cases with the findings in section 4.1, I form the second level of my findings. As a result, I provide both concrete and generalizable insight about how companies select between heavyweight and lightweight automation.

4.1 General findings

In this section, I introduce findings that emerged from expert interviews in Telco Oyj, FinBank Oy, CGI and Digital Workforce (see Table 2, Phase 2). Apart from *Decision making criteria* for selecting automation approach, themes covered in the interviews were *Relationship of RPA and back-end automation, RPA strengths, RPA weaknesses,* and *Typical RPA cases* (see Figure 1). These themes were covered to identify indirect factors that affect selection between RPA and back-end automation. Approach in the interviews was RPA driven, as RPA is an emerging technology and companies are still exploring its possibilities: comparing RPA against "traditional" back-end automation was therefore a natural setting.

Themes are discussed in order presented in Figure 2. When it comes to relationship of RPA and back-end automation, RPA was considered to be one automation tool among many. From this conclusion we get into selection between RPA and back-end automation, which requires understanding strengths, challenges and typical application areas of RPA. By taking all these aspects into account, I derived factors that affect selection between automation approaches.

Figure 2. Themes covered in the interviews

4.1.1 Relationship of RPA and back-end automation

First element covered in the interviews was relationship of RPA and back-end automation. RPA was viewed as welcome addition to companies' automation tool box, and informants considered that lightweight solutions would have been useful in many past automation cases (Annala, Digital Workforce, 21.3.2017; Pursiainen & Penttinen, CGI, 2.3.2017; Immonen, FinBank, 30.3.2017). However, RPA was not viewed as panacea for all automation problems: there was clear consensus that RPA should be viewed as one tool among others, and careful consideration about most suitable tool must be made for each case.

> *"You should remember that [RPA] is just one way of developing the processes, and kind of go processes first, not tools first. - - You have to stay alert of choosing right tools for right purposes."*
> *Antero Immonen, FinBank, 30.3.2017*

It was perceived that tasks that can be robotised could also be automated with back-end methods. System development, Business Process Management –systems, Workflow-automation and Service Buses, among others, were mentioned as alternative approaches. Moreover, companies agreed that RPA and back-end automation are *complementing*, not competing solutions and go strongly hand in hand (Immonen, FinBank, 30.3.2017; Penttinen & Pursiainen, CGI, 2.3.2017; Annala, Digital Workforce, 21.3.2017). In some

cases, parts of the process can even be automated with back-end techniques and other parts with RPA (Immonen, FinBank, 30.3.2017; Pursiainen, CGI, 2.3.2017). Still, informants viewed that RPA and back-end automation have distinct roles: RPA was not regarded to be suitable for the heaviest tasks, and heaviest transaction masses should be left for back-end automation (Annala, Digital Workforce, 21.3.2017).

Also other notions about relationship of back-end automation and RPA were made. It was agreed that coordination with 'traditional IT' and especially with the system owners is extremely important. In FinBank, there is a practice of involving system owners, architecture, security, and risk management for validating that RPA is suitable tool for the process is question (Immonen, FinBank, 30.3.2017). Informants also reminded that RPA relies on well-functioning IT systems, as software robots operate on top of existing systems utilising their functionalities. Therefore, neglecting development of IT systems might lead to unsustainable outcomes (Annala, Digital Workforce, 21.3.2017; Immonen, FinBank, 30.3.2017).

> *"That's the baseline, you shouldn't cheat there, because RPA cannot work if you don't have the base systems, or then your resource planning will soon be based on Excels that the robots are sending to each other, and you'll lack proper data storages and the architecture will become vulnerable quite fast. Everything starts with proper IT systems, and big transaction masses requiring a lot of capacity are better left for traditional integration tools."*
> *Jari Annala, Digital Workforce, 21.3.2017*

4.1.2 RPA strengths

Next theme were the strengths of RPA, especially compared to back-end automation. The most prevalent theme was slightly surprising: there was an overwhelming consensus about RPA's usefulness in automating processes that span over multiple systems. Often, information systems in company's portfolio are built with different technologies and locate in different unit- or technology silos. When process uses multiple systems, integration work required for back-end automation multiplies, which can make automation costly and time consuming. According to Immonen, processes spanning over multiple systems pose challenges for automation also in FinBank:

> *"Many processes require really many systems, and if we think about our system portfolio, it's not like there are two, but I'd dare say hundreds of systems. - - With this type of processes where multiple systems are used, we can quickly say that we shouldn't even think about doing this with a back-end solution."*
> *Antero Immonen, FinBank, 30.3.2017*

Also Telco Oyj has a large and versatile system portfolio, where certain systems have been pain points of automation, like NetInfo introduced later in Case 1 (Peltonen, 21.2.2017). Large system portfolios are not a feature of financial or telco industries alone: cases encountered by Digital Workforce span from insurance to municipal elderly care. According to Annala, customer service and electronic self service are typical spots in organisations where multiple silo systems are used for information input or retrieval (Annala, Digital Workforce, 21.3.2017). In these cases, RPA was regarded useful.

Other often mentioned RPA strengths were cost efficiency and speed of implementation. These were regarded important as they enable capturing automation benefits faster than with back-end automation (Sulmio, FinBank, 17.2.2017): automating one process with software robot was approximated to take on average 3-10 working days (Peltonen, Telco Oyj, 21.2.2017), and the payback times for RPA projects are typically measured in months (Pursiainen, CGI, 2.3.2017). As a result, RPA was regarded useful in small volume or seasonal processes.

It was also identified that RPA enables integrating closed systems. Many companies have legacy systems, built with such technologies that creating interfaces to them today is practically impossible. Also, systems inevitably reach the end of their life cycle, and during the last years there might be no business case for integration. In some cases, system providers don't even want to provide interfaces for their products, leaving companies using the system in a vendor lock-in (Annala, Digital Workforce, 21.3.2017; Penttinen & Pursiainen, CGI, 2.3.2017). Also Telco Oyj experienced a case where a system was maintained by an outside actor and couldn't be modified, and certain interface functionalities were blocked to make automation more difficult (Laine, Telco Oyj, 28.3.2017). In these cases, bridging systems on user interface level with RPA can be the only option.

Moreover, RPA, was regarded to be more flexible and modifiable than back-end approaches. This is useful when process or business rules are still changing: Penttinen and

Pursiainen (CGI, 2.3.2017) viewed that RPA would have been a better solution in many past back-end integration cases, where costs escalated due to changing requirements.

> *"The thing is that if you go with traditional methods you have to get everything right at the first time, consider all of the possible variations. In robotics you don't have to do that. - Also, the [robotized] process starts to produce different kinds of KPI-information that you can use for developing the process further. Manual processes are not very transparent."*
> *Jari Annala, Digital Workforce, 21.3.2017*

Lastly, informants experienced that RPA can enable proceeding with process development despite long IT development backlogs. IT development pipeline can be full with mandatory requests related to for example regulation, and process improvements are not IT's top priority. Therefore, RPA was sometimes the only option for process development in a viable timeframe (Immonen, FinBank, 30.3.2017; Annala, Digital Workforce, 21.3.2017).

4.1.3 RPA challenges

Informants also identified challenges related to RPA. Clearly the most often mentioned theme was change management. This is an expected but apparently underestimated challenge: change management is a task related to all integrations, but with RPA, it's especially challenging. This is because systems' presentation layers typically change more often than data structures behind them: usability improvements and other user requests are more frequent than changes to databases (Annala, Digital Worforce, 21.3.2017). Additional challenge is that humans and robots don't 'see' the interfaces the same way: robots for example understand Windows-resources and read the html-code, and interface that looks unchanged for a human can be different from a robot's perspective, and vice versa (Annala, Digital Worforce, 21.3.2017). Coordination between system owners and RPA team is therefore essential (Immonen, Finbank, 30.3.2017).

> *"The proneness to error is a weakness. In a way, many customers have been able to live with the system cycles: new versions come, and you might just agree that some interfaces or integration are not touched. Now, when a button moves from a site to another, our robot breaks down. - - The traditional models are more simple, as when*

> *you have an interface description, it's easier to maintain that unchanged even if you change the business logic or user interface."*
> *Tuomo Pursiainen, CGI, 2.3.2017*

Also, RPA was not experienced to be quite as lightweight as sometimes promised. RPA is often described as fast and easy automation, where business users with subject matter expertise but no coding skills could automate processes with a few weeks of training (Lacity & Willcocks, 2015). However, informants agreed this is far from the reality.

> *"Let's say that in the beginning, RPA was marketed to us as really easy and really fast. It was described as 'this is not system development at all' –type of a thing, where business could just develop and boost its own processes itself. Well, by the experience that we have now developed, it's not quite that rosy."*
> *Antero Immonen, FinBank, 30.3.2017*

Two main reasons were the need for specific RPA-capabilities and RPA sharing many requirements with traditional system development. At the end of the day, training software robots requires many same skills as coding, even if it's done using graphical interfaces. At very minimum, an algorithmic way of thinking and knowledge of basic principles, such as loops, processing strings, and handling items in data tables are needed (Annala, Digital workforce, 21.3.2017). Also, requirements specification and change- and error management are needed in RPA, too (Immonen, FinBank, 30.3.2017). To conclude, RPA was not regarded as rosy as the current discussion suggests.

Moreover, access rights and security were mentioned as challenge causing surprising amounts of work (Penttinen, CGI, 2.3.2017). RPA is claimed to be secure, as it operates on top of existing systems and as the actions of robots are traceable (Lacity, Willcocks & Craig, 2015/04). However, these claims overlook some problems. Firstly, back-end integrations are system-to-system by nature, whereas software robots need access to all systems used in the process. Especially when configured to perform many processes, robots can end up having considerably wide access rights. This "super user-problem" sets new kind of security challenges for companies (Pursiainen, CGI, 2.3.2017). Lastly, as Immonen (FinBank, 30.3.2017) put it, RPA is not a sledgehammer to hit everything with and not suitable for the heaviest transaction masses. RPA is limited by the existing systems and their interfaces: exchanging data through user interface is considerably slower than

through database layer, and RPA is not the right tool when the number of transactions rises to tens or hundreds of thousands per day. Also, although software robots could theoretically work 24/7, the existing systems and for example batch processing can reduce effective operating time significantly (Sulmio, FinBank, 17.2.2017).

4.1.4 Typical RPA cases

Also characteristic cases where RPA seems to shine emerged during the interviews. Due to being cost efficient and fast to set up, RPA is ideal in temporary processes where containing costs is important. Informants brought up two typical situations in different ends of process life cycle: prototyping new services and automating processes that use end-of life cycle systems.

Informants from all companies mentioned building new services as one RPA use case. It was experienced that although RPA is mostly used for optimising existing processes, service design and prototyping are very viable use cases (Penttinen & Pursiainen, CGI, 2.3.2017). Creating a functional pilot service can be considerably cheaper, faster, and thus less risky when using RPA rather than back-end automation.

> *"Quite often, these are such cases that we make a temporary integration with robots to get it done fast, here and now, so we can for example test a new service model or process with fail fast –mentality. When we know that customers have adopted the process, we can implement it with some other tools. - - I believe that in many companies, [RPA] will be the next step after trying out concepts with the cardboard prototypes, when you actually want to start automating a bit."*
> *Jari Annala, Digital Workforce, 21.3.2017*

At the other end of system life cycles, RPA can enhance processes where system development is no longer economical. Instead of subsisting with the dying system and manual processing for few more years, companies can boost these processes with RPA. Informant from Telco Oyj concluded very nicely:

> *"There are two points where RPA is great. The first is when software is in the beginning of it's life cycle, and the other is when it's in the very end. Those are the integration points. In the beginning, RPA is fast when you have to get some integration done, and in the end of the life cycle, there is no point for system*

> *development. But in the middle it probably makes sense to build back-end integration, because when you are handling masses, it's much easier with proper integration."*
> *Lari Laine, Telco Oyj, 28.3.2017*

Moreover, RPA can be more flexible in cases where automation requirements are still changing: modifying back-end implementation on the fly is costlier. Adding exceptions and variations to automation afterwards was also regarded to be easier with RPA (Annala, Digital Workforce, 21.3.2017). Lastly, the final case where RPA shines is inputting or retrieving data from silo systems. This can be needed for example to ease experts' work by constructing reports or conducting background checks, or to help companies to move towards multi-channel customer services. Typically, processes utilising silo systems can be found in customer service processes (Pursiainen, CGI, 2.3.2017; Annala, Digital Workforce, 21.3.2017).

4.1.5 Decision making criteria

Lastly, we get to the direct decision making criteria that companies use for selecting automation approach. Immonen (30.3.2017) told that FinBank uses business case, scope and time to market as three high level decision making criteria. *Business case* was the fundamental decision making criteria shared by all interviewed companies, and all of the other criteria can even be seen as input to it. Estimating business case requires comparing costs of manual process to implementation and running costs of each automation approach. Having clear understanding of all of these components is necessary for reliable estimation – however, it is also challenging. In some cases, of course, selection is trivial:

> *"Amount of work is one indicator, so we talk about the amount of work going into RPA development or integration development. In we have a case that we have to handle for half a year, and it takes half a year to get the integration ready, then we don't have a business case – but if we can get it working in a month with software robots, then we have a business case."*
> *Tuomo Pursiainen, CGI, 2.3.2017*

Scope refers to how well each approach fills the automation requirements: in practice, how big part of the process could be automated with selected approach

(Immonen, FinBank, 30.3.2017). This affects directly to the man hour savings that can be achieved with automation. *Time to market* is important, as it tells how quickly the automation benefits can be realized. Immonen told that time is very important perspective in FinBank's process improvement. Slow implementation can also rule out some solutions completely, if automation is time critical (Pursiainen, CGI, 2.3.2017). According to Immonen, FinBank uses these three factors (business case, scope and time to market) iteratively to find the best process development approach.

In addition to above mentioned factors, one additional decision making criteria was mentioned. That was the *anticipated development of system architecture*. Immonen told that after business case has been estimated, FinBank evaluates suitability of RPA again with a group of stakeholders, including for example architecture, system owners, security, and RPA specialists. This group considers for example are some changes anticipated to systems that would affect suitability of RPA. Considering future changes was regarded important, as it affects life cycle and benefits of automation. For example, if RPA has been considered for integrating a legacy system with no interfaces, but system will be replaced in six months, the task might not have top priority.

> *"So that is one selection criteria as well: if we notice that some other than RPA development is planned for near future, then we should consider is it sensible to implement such a short lived solution with RPA."*
> *Antero Immonen, FinBank, 30.3.2017*

All in all, four high level decision making criteria were identified: these were *Business case, Scope, Time to market*, and *Anticipated development of system architecture*.

4.1.6 Factors affecting selection of automation approach

Finally, I summarise the insights presented in sections above into a set of factors affecting companies' selection between automation approaches. These can be categorised in two groups: *high level decision making criteria* that companies reported to use for choosing automation approach, and *heuristics* that seemed to indicate that one of the approaches would be more suitable. All factors are presented in Table 3.

High level decision making criteria were discussed in section 4.1.5, and will therefore not be covered again here. In the following, I will instead provide summary about

the heuristics: that is, factors that were identified to affect suitability of automation approaches, but were not necessarily considered as decision making criteria.

Table 3: Selection criteria for automation approaches

High level decision making criteria		
Criterion	**Description**	
Business case	What are the current manual costs versus costs of implementing and running automation (with each approach)?	
Scope	How big part of the process could be automated (with each approach)?	
Time to market	In what timeframe can automation be implemented (with each approach)?	
Anticipated development of system architecture	What kind of changes in system architecture are anticipated in the coming years? How does this affect attractiveness of each approach?	
Heuristics		
Factor	**In favour of RPA**	**In favour of back-end automation**
Number of systems	Process uses multiple systems	Process uses only one system
Process volume	Moderate to high process volumes	Very high process volumes
Changes anticipated in automation requirements	Changes anticipated in automation requirements	Stable process and requirements
Stability of user interfaces	Stable user interfaces	User interfaces change regularly
Interfaces between systems	No interfaces between systems	Systems have existing APIs
Time to market	Automation is time critical	Automation is not time critical
Permanence of process	Process is temporary	Process is permanent
IT resource situation	IT pipeline is full	IT development resources are available

Most of the heuristics that seem to affect suitability of different approaches were not included in high level decision making criteria. One of these is *number of systems*. As noticed in section about RPA's strengths, RPA shines in processes where multiple systems are used. On the other hand, if automatable process uses only one system, system development might be more meaningful approach. Pursiainen (CGI, 2.3.2017) viewed that in a case where only one system is used, they would rarely implement RPA. Informants had very aligned views about this matter, and number of systems should be considered as an important heuristic.

Another factor to consider is *process volume*. RPA was viewed to perform well in cases where volumes cause considerable burden for human handlers, but daily transactions aren't moving in tens or hundreds of thousands. For mass processing, back-end automation was viewed to provide more efficient solution (Sulmio, FinBank, 17.2.2017; Annala, Digital Workforce, 21.3.2017; Penttinen & Pursiainen, CGI, 2.3.2017). Thirdly, it was identified that companies should consider *changes anticipated in automation requirements*, especially in the near future. RPA was considered to be more flexible than back-end automation when it comes to changing requirements on the fly: in back-end automation cases, changing requirements or adding exceptions was deemed more expensive and challenging. Therefore, if process is still changing during time when automation must be implemented, RPA is more suitable option.

Fourth factor was the *stability of the user interfaces*. Although RPA is lighter to change than back-end automation, it must be updated when system's user interface changes: thus, change management can be challenging. Implementing back-end integration is typically costlier, but database structures change relatively rarely. Thus, if process and business rules are stable but system interfaces live constantly, back-end automation can be preferable.

Moreover, *interfaces between systems* define very much which automation approach is more suitable. RPA is typically used in cases when there are no existing interfaces: for example, integrating closed systems where building interfaces would be impossible, risky or expensive. However, if modern APIs are available, back-end automation can be relatively easy to implement.

> *"If we would have some lovely and easy interface or REST calls or such, of course we would use those. Those are used when available, also in robotics: we can access some systems with APIs instead of user interfaces. But usually, in the end: why wouldn't we have already done this with traditional methods if it was so easy and straightforward?"*
> *Tuomo Pursiainen, CGI, 2.3.2017*

Also the *timeframe* in which automation must be delivered determines the selection. This was the only heuristic included also in the high level decision making criteria. Typically, RPA is much faster to implement than back-end automation, given that RPA production environment is already in place. Therefore, if setting up automation is

critical due to for example regulation change or competitor's actions, RPA can serve as quick fix. It was estimated that typical development time in RPA is around two weeks (Annala, Digital Workforce, 21.3.2017). However, if time is not a critical factor, one of most appealing aspects of RPA loses importance.

The quick setup is related also to *permanence of process*. If the automation solution is permanent, benefits of back-end automation probably exceed the benefits of RPA in the long run. However, if automation is set up only for a limited time, like is the case with prototyping a news service or automating process that uses dying system, RPA is more economical. However, it was perceived that if transaction volumes are small, RPA could be used as a permanent solution, as its operating costs are relatively low (Pursiainen, CGI, 2.3.2017).

Lastly, *IT resource situation* can affect selection of approach. It was experienced that mandatory development often fills the IT development pipeline, and RPA can enable implementing process development in feasible time (Immonen, FinBank, 30.3.2017). However, this claim should be treated with some caution, as it was also experiences that co-operation with traditional IT is important in RPA, and specific capabilities are required for RPA. Therefore, RPA will inevitably utilise also IT resources. However, after companies have acquired RPA capabilities and their RPA departments are up and running, it's probably true that RPA enables bypassing traditional IT development pipeline and delivering solutions faster.

To conclude, I identified eight heuristic elements affecting to companies' selection: *Number of systems, Process volume, Changes in automation requirements, Stability of user interfaces, Interfaces between systems, Time to market, Permanence of process, and IT resource situation.* Next, I move to the case studies conducted in Telco Oyj. By comparing decisions made in these cases to the factors identified above, I can validate the findings and provide more insights about the topic.

4.2 Case studies in Telco Oyj

In the following I describe two automation cases that were observed in Telco Oyj. In both cases, automatable manual process was identified and RPA and back-end automation were considered as alternative approaches. By the time these cases happened, Telco Oyj was only assessing RPA possibilities and setting up its robotics operations. Therefore, to

evaluate RPA's suitability for the processes, Proof of Concept RPA-implementations were built for both cases, and external partners were involved in the implementation.

RPA pilots were conducted during year 2016. After Telco Oyj started its RPA operations, processes were taken into production in spring 2017. Pseudonyms are used for referring to most systems and companies involved in the cases. When mentioning a system or a company for the first time, pseudonyms are marked *'in the following manner'* for the sake of clarity.

4.2.1 Case 1: Availability check of fibre-Ethernet product

Background

The first automation case was related to a process in Telco Oyj's Corporate Customers – unit. The process was availability check of fibre-Ethernet product – in short, checking is there available capacity to sell when a bid for Ethernet-product arrives. Availability check is only one phase of bid processing: most of the process was left for manual handling, as it requires expert insight. The team operating the process operates the billing of tele, operator broadband, and capacity products.

The process had various aspects that made it tempting target for automation. First of all, the fibre-Ethernet is one of the most frequently requested products in the unit, thus the process volumes are higher and potential benefits of automation bigger. At the same time, the product and process are relatively simple: after the steps are mapped, conducting capacity check is rather straightforward. Moreover, although human users utilise up to four different systems in the process, it was possible to complete it with two, which would make configuration of software robots more straightforward if RPA was chosen.

One important gain expected from automation was easing service specialists' work. Many checks need to be conducted during the process, and the goal was to find out could automation assist the experts - previously, process involved no automation. When it comes to the RPA-pilot, the goals included also learning more about RPA's capabilities and training, running and costs of software robots. Team wanted to get first-hand experience about how software robots perform with systems used in the process: some systems are web based, and some have previously been a pain point of automation. Initially, the team also hoped to already gain capabilities to use the robots independently during the pilot. However, this proved to be outside the scope of the pilot. The conclusion was that developing own RPA capabilities is possible and necessary, but takes more time.

People involved in the RPA-pilot included project owner and project manager, who were from the team that operates the process. Also representative of company IT was involved, taking care of matters related to system interfaces and arranging credentials for the external consultants. Corporate Security took care of the required security clearances. External parties involved consultants from partner company, who configured the robots based on documentation and process walk-throughs with Telco Oyj's team.

The discussions in project steering group started during spring 2016, and in March, it was decided that a Proof of Concept RPA-implementation would be made. At this point, also the partner company and platform were selected. After completing the security clearance process, the actual kick-off meeting was held in the end of May. 10 man days were reserved for configuring robots, which was sufficient: this included a kick-off day held on-site, about 7 days for teaching the robots and finally reporting for the PoC. PoC was built in June 2016, and the closing meeting was held in beginning of July. After RPA-pilot was completed, implementation was put on hold while exploring other automation possibilities. In the end, RPA was found to be the best approach: after Telco Oyj started its RPA operations, the process was going into production in May 2017.

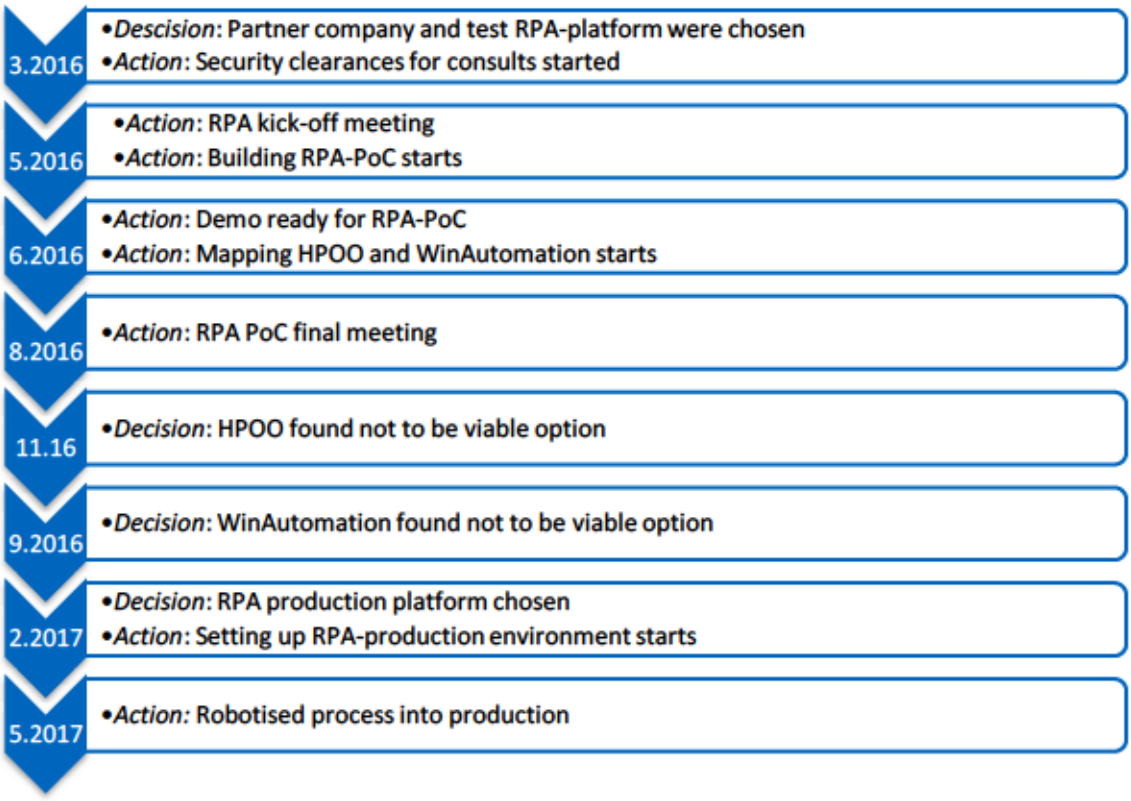

Figure 3. Timeline of Case 1: fibre-Ethernet

Process before RPA

Before RPA, the process was as follows:

A customer bid arrives through a web portal to order and bid delivery system *'OrderSys'*. Bid is automatically directed to a correct work queue according to the product, and a service specialist takes it for processing. The specialist checks basic information, including what was ordered and to which address. Next, he uses the address to find out which distribution point is serving it (in bigger locations there might be multiple distribution points). For this, specialists can use either address register system *'Adresso'* or map application *'Maps'*. From Maps, specialist can visually see the building and relevant information: what type of distribution points there are, is there fibre or copper, is there a switch, and so forth. Also, after identifying the correct distribution point, he can see its ID. After finding the ID, specialist opens network information system *'NetInfo'* and finds the same distribution point from there (specialists typically do this using the ID, but it is also possible to find the distribution point using the address from OrderSys). Now, specialist can see is there capacity available. Required information includes is there a fibre going to the location, is there capacity on the fibre, is there a switch at the location, and if so, are there available ports at the switch. After checking this information, specialist is ready with the capacity check and can move to next phases of processing the bid.

The process above describes how a human user typically conducts the capacity check. However, process can be completed using only OrderSys and NetInfo. This is because getting the distribution point ID from Maps or Adresso is not necessary: distribution point can be found from NetInfo using the address retrieved from OrderSys. However, for human users, Adresso and Maps offer more versatile visual information that makes processing the bid easier. For software robot, visual information doesn't add value, although it was discussed that robot could be trained to identify certain things from the map application as well.

Process after RPA

After the RPA-pilot, the process was as follows (see also Figure 4):

Software robot logs into OrderSys, opens the correct work queue and sorts the tasks by date from oldest to newest. Next, robot opens the oldest ticket and checks the product from description field. If product is wrong, robot moves to next ticket - if the product is correct, robot continues by checking speed and address information. After this, robot opens NetInfo and finds the correct distribution point using the address fetched from OrderSys.

This requires feeding in the address, and then navigating the tree-structure of the system step by step: information in NetInfo is organised as a tree, where branches are opened by clicking. The tree structure proved challenging, as there can be a great number of branches: for example, if the fibre goes through multiple distribution points, the path can become very long. However, in the end it was possible to train the robot to navigate through the tree, finding and following the correct fibre trail to the end.

At the end of the trail, software robot checks if there is free fibre capacity at the location. After this, robot returns an answer in text format to OrderSys. It is important that the robot returns an informative answer for human specialist, as this is needed for pricing the bid: is there fibre, is there switch, are there ports and do these have free capacity. At its simplest, the answer can be "No fibre trail". Finally, after returning the information text, robot moves the ticket to next queue and continues with the next task in line.

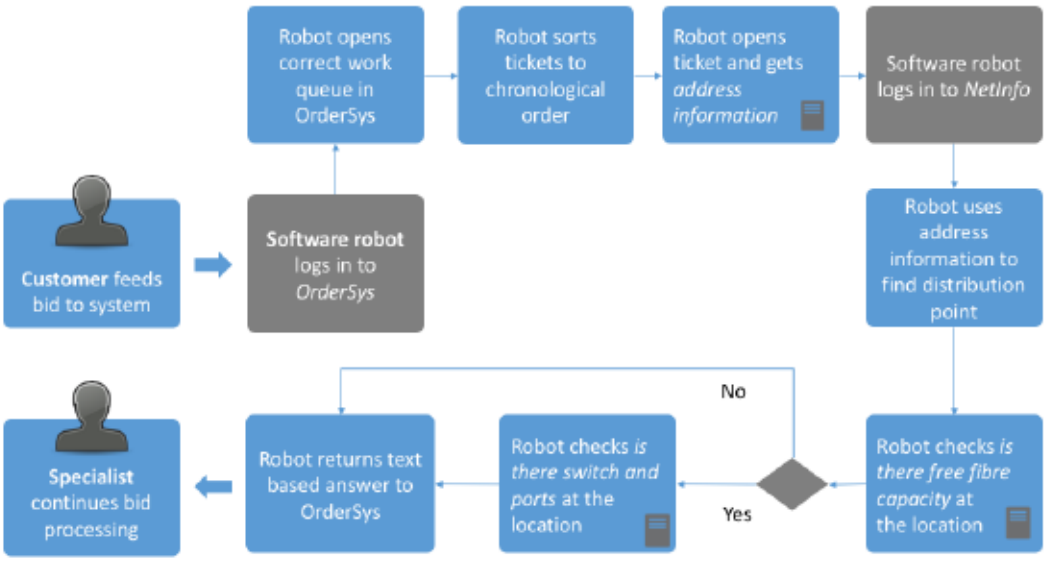

Figure 4. Process in Case 1 after RPA

No exceptions or errors were faced where the robot would return task to manual handling. However, when the RPA will be taken into production, it's likely that "No fibre trail" –answers would be double checked by human specialists to make sure the robot has checked all possible distribution points. In this case, big part of the process remained manual. Processing the bids requires expert judgement: after receiving availability check results, expert accepts or rejects the bid, determines the pricing for accepted bids and

finally answers to customer. Robot's task is simply to provide background information for experts' decision making.

Decisions: RPA versus back-end automation

When RPA was piloted for this process, alternative automation approaches were also explored. In this case, decision between RPA and back-end automation was not entirely straightforward. The two considered back-end automation approaches were WinAutomation and HP Operations Orchestration (HPOO).

Various people looked into HPOO-alternative, as it seemed very promising at a first sight. HPOO was already at use in other processes, and it was therefore a tempting to utilise it also here: processes and organisation were existing and the software was proven to work. Also, based on the initial investigations, it seemed likely that automating the process with HPOO would be possible.

However, during investigations, problems started to occur. The first challenge was lack of interfaces: there was no existing interface between OrderSys and NetInfo, so automation would have required development in both systems, as well as building the interface. Building the interfaces would alone have taken several months and required lot of investments (Peltonen, 2017), and the overall schedule did not seem favourable. Also, HPOO was not able to use NetInfo, but only the databases behind it: not all data could have been fetched from the databases without extra work. As retrieving the data proved more challenging than thought, it was uncertain could the process be automated completely or only partly (Peltonen, 2017). On top of this, it was realised that involvement of a third party would have been required: every time there would be changes to the automation, the work would have to be bought outside the house. Moreover, coding work done for this specific environment would be hard to reuse in other processes. All of this combined, the estimated costs of the project started to escalate.

> *"So the snowball was just growing constantly with HPOO. First it felt good and clear: we have the software at use already and it's noteworthy. But when we went deeper and investigated the matter with various experts, we found a surprising amount of development that needed to be done, building interfaces, fetching information, and so on."*
> *Tuija Peltonen, Telco Oyj, 21.2.2017*

In the end, it was decided that the team would not proceed with HPOO. The other explored alternative was WinAutomation, which was more lightweight approach and somewhat resembles RPA. WinAutomation is a Windows-based platform, whose desktop and web automation promises to deliver "powerful and easy to use Windows based platform for building Software Robots" by "leveraging WinAutomation Macro and Web Recorders" (WinAutomation, 2017). However, when Telco Oyj examined the possibility of using WinAutomation's solution, it was found that it wasn't able to operate with OrderSys. OrderSys is a web-based application, but it *can't* be used with Internet Explorer, whereas WinAutomation's product operates with Internet Explorer. As a result, also this alternative was ruled out.

Finally, RPA was found to be the best solution for automating the process. This was because of the ease and short implementation time, as well as flexibility and adaptability of software robots, as they were able to operate in different environments. During the process, project manager Peltonen was forming a picture of strengths and weaknesses of RPA. According to her, clear benefits are the easy integration of systems, and the possibility to automate also terminal phase processes where back-end integration is no longer a viable option. Possibility to add capacity to process quickly was also appreciated. Peltonen told that in this case, team also hoped to see improved quality and fewer errors in the future. This was partly based on assumption that RPA would improve employees' work satisfaction, although it had been received with some caution:

> *"In the beginning it's scary, the change. It could be seen already during this pilot: there were careful questions coming from people about how this will affect the job descriptions. I had to tell them that, look, don't pack your things yet, but try to see this in the bigger picture: the primary goal is not to have less people, but to improve the quality of work. I believe that in the long run we can move expert work to tasks really requiring our input, like personal customer service. Personally I hope that there are more opportunities than threats in the future."*
> *Tuija Peltonen, Telco Oyj, 21.2.2017*

Conclusions

To wrap up, this case demonstrated very well the selection between RPA and other automation approaches. Some factors that were identified in the expert interviews (summarised in section 4.1.6) affected the decision also in this case. These included at least

Interfaces between systems (as there was no existing interface between OrderSys and NetInfo), *Time to market* (as it was considerably longer for HPOO solution than for RPA), and in a way also *IT resource situation* (in the sense that system development would have been required for both OrderSys and NetInfo). Therefore, this case seems to validate that at least these factors have real significance in companies' decision making.

4.2.2 Case 2: Adding new service to customer's EntertainED subscription

Background

The other automation case was conducted in Telco Oyj's Consumer Customers -unit. The automated process was adding a new entertainment service (called hereafter *'MyChannel'*) to customer's existing *'EntertainED'* subscription. EntertainED is Telco Oyj's subscription based online entertainment service, where customers can stream, record and watch content of various TV channels and content producers using multiple devices.

Before implementing RPA, the process of adding MyChannel-service to customer's EntertainED subscription was outsourced to a partner. Therefore, Telco Oyj faced a fixed cost associated with each MyChannel -purchase. Also, the process volume fluctuates quite a lot, as the demand for MyChannel is seasonal: time of the year and certain events influence the demand, and Telco Oyj sent monthly an estimate of the next month's demand to its outsourcing partner.

The wanted outcome of automation was automating the manual processing of MyChannel subscriptions and having an end-to-end subscription automation for EntertainED users. As a result, customers' subscriptions would be delivered faster, and the number of human errors could also be reduced. When it comes to the RPA pilot, RPA was estimated to lower the data entry cost associated to MyChannel subscriptions. The team wanted to also gain more understanding about RPA's capabilities, including how RPA manages handling data from different sources, and how much effort does automating a process with RPA really take. To compare the capabilities of different RPA platforms, the Proof of Concept was in this case built with three different platforms. One of the examined platforms was eventually chosen for production in Telco Oyj.

The pilot was started on September 2016 with a demo session, where Telco Oyj employees demonstrated how the manual process was conducted. The process was recorded by consultants from partner company, who built the RPA-implementation using about 24 man days. When presented to Telco Oyj's team in November, the PoC was considered a success: RPA could perform all of the specified tasks. However, the team

noticed that the process would still need some development before it could be taken into production. After setting up the RPA production environment started, modifications were made to the process during April 2017. The process went into production on May 2017.

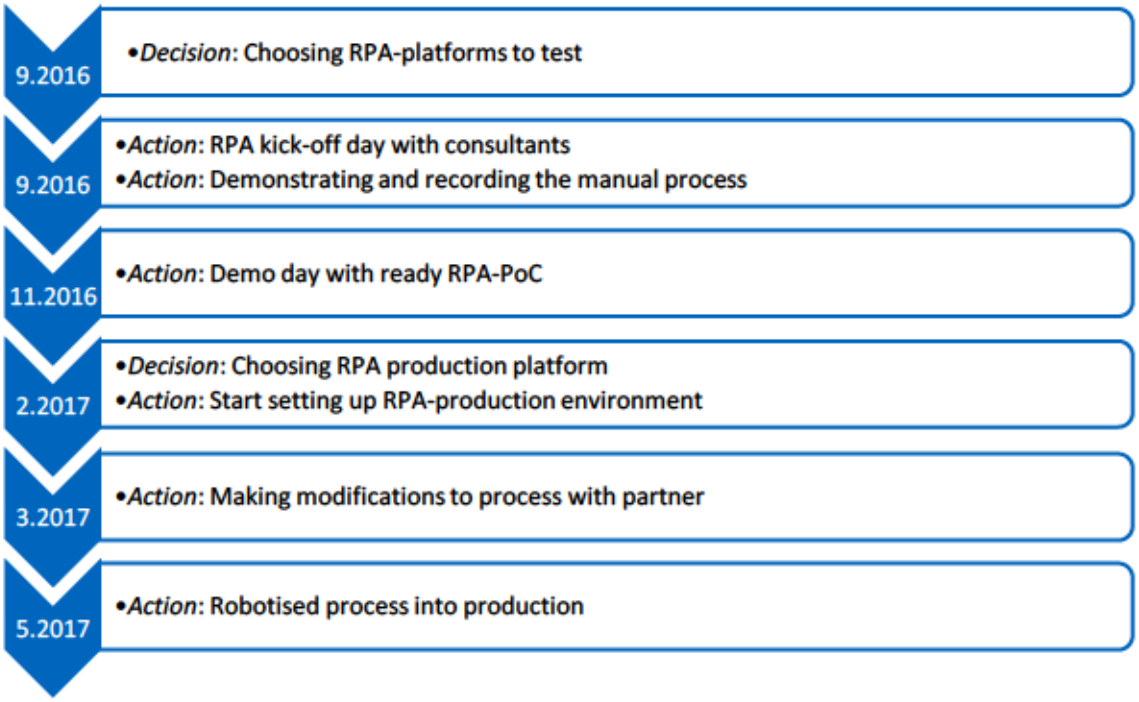

Figure 5. Timeline of Case 2: EntertainED

Process before RPA

When conducted manually, the process was as follows:

The possibility of adding MyChannel-service to their EntertainED subscription is promoted to subscribers by the sales personnel of company called hereafter *'Channels Inc'*. Once a day, Channels Inc. generates a list of customers who wished to add the service to their EntertainED subscription and delivers it to Telco Oyj. The list is in Excel-format, and it's sent as an email attachment to a dedicated mail address, which directs it to a correct category in the ticket-system (a module of the CRM system for consumer customers). When the email arrives, employees at Telco Oyj's outsourcing partner see that a new task has appeared and can start processing it.

Each row in the Excel contains information about customer and about the specific Channels Inc. product they wish to add to their subscription. Handler from Telco Oyj's outsourcing partner logs in to the ticket system and opens the attached Excel file. Handler then checks contract number in Excel column D, and using the contract number, conducts

a search in the CRM system to fetch customer ID. The customer ID is then used to search Subscription Tool in the CRM-system and to find Telco Oyj device assigned to the customer. Campaign and the name of the product that customer wishes to purchase are in Excel column K. In the Subscription Tool, handler selects the product from a list of products available for the customer's device. The order is placed and then processed by CRM system.

Process after RPA

After RPA pilot, the process was as follows (see also Figure 6):

User logs in to the CRM, after which all steps are done by the software robot. In the ticket system, the robot selects the correct ticket category, opens ticket and downloads Excel-file. Robot then starts processing the Excel row by row. It gets contract information from Excel column D and moves to the search page on the CRM-system. Robot then uses contract information to find customer ID from the CRM-system. After finding customer ID, robot moves to CRM Subscription Tool and chooses defined category and subcategory. It finds the service ordered by customer from Excel column K, and chooses the same service from the Subscription Tool menu. Finally, robot feeds customer ID and correct service to Subscription Tool and moves subscription forward. After this, robot repeats the same procedure until all Excel rows are processed.

If robot faces exceptions, it moves the order for manual handling. These exceptions include cases when text has been added to the comment field in a format that robot doesn't understand. For example, if sales person has agreed with the customer that order confirmation will be sent by letter, this information is added to the comment field and robot will move the order for manual handling.

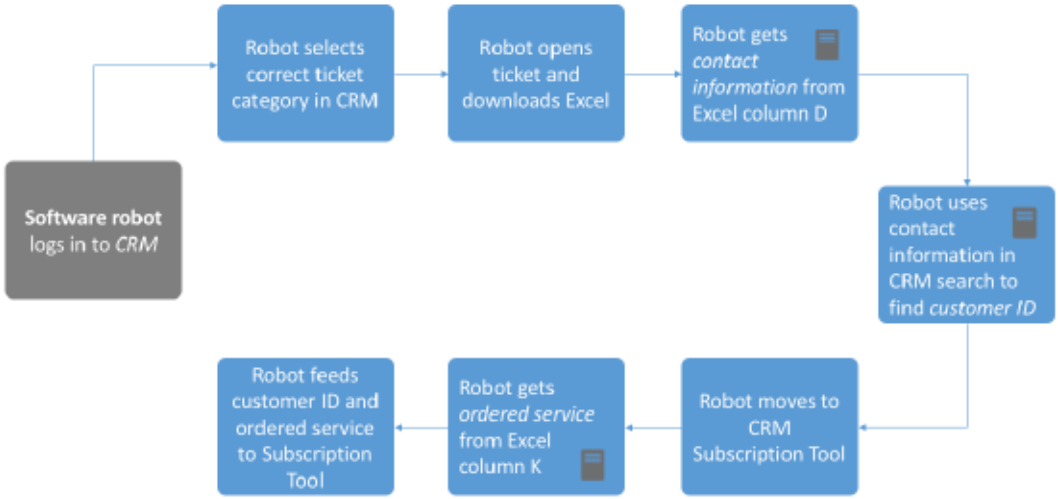

Figure 6. Process in Case 2 after RPA

After the RPA PoC was ready, it was noticed that some modifications should be made to the Excel before moving the process into production. In the original Excel, name of the product could be found in column K, but there was no product number corresponding to the one in Telco Oyj's system. This meant that Channels Inc. had to add a product number -column to the Excel they delivered to Telco Oyj. Also, in the production implementation, robot was timed to process the orders on working days at 5pm. No manual involvement was therefore needed for starting the process. These modifications were made, and process was successfully taken into production.

Decisions: RPA versus back-end automation

In this case, decision between RPA and back-end automation was clearer than in the previous case. After RPA-pilot was ready and proven successful, it was concluded that this process would likely have been automated sooner or later – but with what technique was harder to say. However, Miika Hirvonen (Service Manager, Order Management) perceived that it was likely that there would have been challenges with traditional IT-development. First of all, the Excel and email -based system for transferring the subscription data would have needed renewing. As the process involves receiving information from an external party, Channels Inc., back-end automation would have required modifying also processes of Channels Inc. This could bring along more uncertainties and dependencies, as

completely controlling a process spanning over company borders is not possible. With RPA, modifications to the existing processes – apart from adding a column to the Excel – were not necessary.

> *"Probably we should have renewed the Excel-transmissions. We would have needed some other form of sending [data], and probably some form to fill, so it would then automatically 'swim' forward in IT. So in a way, if we would have started this with 'normal IT', we should have renewed also the process of Channels Inc."*
> *Miika Hirvonen, Telco Oyj, 22.2.2017*

Also, the process is still likely to develop in the future. Hirvonen pointed out that work with process improvement is never ready: according to him, continuous improvement is the key, and process should continuously be developed to a more customer-centric direction. Hirvonen envisioned that if RPA seems to work well, there is no showstopper for automating the process so that Channels Inc. could fill in orders right after talking with a customer, for example through a webpage. Orders would then be transferred to Telco Oyj's system and could be handled immediately, further reducing the time between order and delivery.

Learnings from the pilot included also that standardising processes plays an important role in RPA. According to Hirvonen, RPA-pilot gave a kick-start for process standardisation in this process area. Also, Telco Oyj employees involved in the pilot were positively surprised about capabilities of RPA, and automation process was deemed relatively smooth. Due to positive experiences from the two described cases, next RPA candidates were already under mapping.

Conclusions

Also in this case, we can observe same factors that were identified in expert interviews. At least *Interfaces between systems* (as the way of transferring data should have been renewed in system development approach) and *Changes in automation requirements* (as the process was likely to develop in the future, when improvements could be made) had an effect on Telco Oyj's decision. It is likely that also *Process volumes* affected the selection (as they were not very high but were fluctuating based on the season). Additionally, one more potential factor emerged in this case: it should be considered *is the process spanning over company borders*. In this case, involvement of Channels Inc. caused additional challenge

for back-end automation, as also process of Channels Inc. would have required renewing. Some modifications were needed also for RPA, but these were minor in comparison. Therefore, I hypothesise that RPA can reduce dependency on external parties when process spans over company's borders.

Now that I have described the findings from the expert interviews and two automation cases observed in Telco Oyj, I move to section 5, where these findings are discussed in the light of existing literature.

5 Discussion

In the empirical part of this study, I looked into how companies select between RPA and back-end automation. From the expert interviews, I identified four high level decision making criteria and eight heuristic factors that seemed to indicate suitability of either approach. The decision making criteria were *Business Case, Scope, Time to market,* and *Anticipated development of system architecture*. These factors were actively considered by informants when selecting automation approach. However, also various other factors that affect on which approach is more suitable were revealed in the analysis. The identified heuristic factors were *Number of systems, Process volume, Changes in automation requirements, Stability of user interfaces, Interfaces between systems, Time to market, Permanence of process, and IT resource situation.*

In the case studies, five of these heuristics were observed to affect decisions made by Telco Oyj. These were, in rough order of significance, *Interfaces between systems, Time to market*, *Changes in automation requirements*, *IT resource situation* and *Process volumes*. As only two cases in one company were observed, it is not surprising that all factors were not involved. It can be concluded that findings from cases studies and interviews are aligned. This is encouraging, as the identified factors therefore seem to have real relevance. Additionally, one more potential factor emerged during the case studies, that being the *Process spanning over company borders*.

Case studies provided insight about how companies select automation approach, but also about at which *stage* of decision making factors are considered. Based on both cases and expert interviews, it looks like companies do not *proactively* consider all, or even most of the factors that affect their decision by the end of the day. The trend seemed to be that the effects of heuristic factors only came up when looking into chosen approach more deeply, or when problems occurred. The exception is time to market, which was considered also as a decision making criteria. None of the interviewees reported to use any checklist of factors that should be considered about different approaches. Naturally, as the data set contains only four companies, findings about decision making strategies are not completely generalizable. Nevertheless, stance of this study is that companies would benefit from recognizing and considering also the heuristic factors earlier in their decision making.

Most of the findings of this study are supported by existing literature, but also contradicting viewpoints and new emphasis were revealed. Table containing factors

identified in this study and related citations from literature can be found in Appendix E. In the following, I discuss the findings in more detail and in the light of the existing literature.

5.1 High level decision making criteria

The high level decision making criteria identified in this study were mostly based on those used by FinBank, although they were also backed up by other companies: *Business case* and *Time to market* were considered by most informants. These criteria seem to be generally aligned with existing literature. Business case is the fundamental factor defining companies' decisions, and the other factors can even be seen as mere input determining its outcome. Penttinen and Asatiani (2016) and Mohapatra (2009) conclude that to estimate ROI of automation in a reliable manner, companies must understand both the current manual cost structure and setup costs of automation, as well as automation's effect on for example product quality. Although RPA can enable automating processes that have previously been economically "out of reach" (Barnett, 2015, p. 14), careful consideration about long term effects of is needed: in the end, automation should ensure both quality and cost-effectiveness (Mohapatra 2009, p.7).

Scope of automation and *Anticipated development of system architecture* were only mentioned by FinBank, and are not addressed very thoroughly in the identified literature. However, some support also for these decision making criteria can be found. Mohapatra (2009, p.9) states that automation should be done with most suitable implementation, considering also future changes in the environment: it must be ensured that updating or replacing the system is possible. This notion covers both of the mentioned viewpoints: when selecting automation approach, companies should consider both what is the best solution for current situation (scope) and how does it cope with future development (anticipated development of system architecture).

5.2 Heuristics

Next, I will briefly discuss each heuristic element identified in this study.

Number of systems

In this study, it was identified that number of systems used in process affects selection of automation approach. Consensus was that when process uses multiple systems, RPA tends

to be more suitable solution than back-end automation. On the other hand, when only one system is used, back-end automation was regarded more meaningful.

From the literature, we can find strong backing for this finding. Willcocks et al. (2015/05, p.5) view RPA ideal for replacing people in so called "swivel chair" processes, where humans take input from one set of systems, process it and enter the output to other set of systems. Also Penttinen & Asatiani (2016, p.3) mention "need to access multiple systems" as one criteria of RPA suitable processes. Moreover, Willcocks et al. (2015/06, p.9) reported successful RPA implementations in cases where data from various non-integrated sources had to be combined. Unsuitability of back-end automation when process uses multiple systems has not been discussed in similar scope. However, this conclusion seemed self-evident in the interviews, as processes spanning over multiple systems often remained manual, as they were uneconomic to address with "traditional" automation approaches.

Process volumes

Also process volumes were identified as a clear factor defining selection between RPA and back-end automation. Informants reported that RPA performs well with relatively high transaction volumes, but the heaviest transaction masses should be addressed with back-end solutions. This finding, too, is supported by literature. Penttinen & Asatiani (2016) recognise that while front-end integration provides flexibility and quick implementation, its performance is inferior to back-end integration designed for machine-to-machine communication. However, concrete volumes suitable for each approach are defined in somewhat ambiguous manner: it is often noted that RPA suits for 'high' transaction volumes (eg. Lacity, Willcocks & Craig, 2015/04, p.9), while it's simultaneously supposed to be optimal tool for addressing processes in the long tail of automation, where back-end automation is no longer economical. Thus, volumes suitable for each approach required defining.

In the interviews, informants viewed that when transaction volumes move in tens or hundreds of thousands per day, RPA might not be suitable. On the other hand, Willcocks et al. (2015/04, p.10) report that Telefonica O2 has defined that process must save a least three FTE to be addressed with RPA. In their paper "The IT Function and Robotic Process Automation" (2015/05) Willcocks et al. introduce successful RPA cases from Telefonica O2 and Xchanging (see Table 4). Based on the numbers they provide, we can estimate that in these cases, transaction volumes move in thousands per day, at maximum. As a result,

we get *approximate* volume boundaries: when process volumes are such that at minimum 3 FTE can be saved, but transactions can be measured at maximum in thousands per day, RPA is suitable approach. When volumes are higher than this, back-end automation should be applied.

Table 4: Volumes reported in RPA cases by Willcocks et al. (2015/05)

	# Processes automated	# RPA transaction per month	**# Estimated transactions per day per process**
Telefonica O2	15	400 000 to 500 000	**1000**
Xchanging	14	120 000	**290**

Changes in requirements

In this study, it was also found that changes anticipated in automation requirements affect selection of approach. Based on the interviews, RPA is useful when changes are anticipated to process or business rules. This is because RPA is quick not only to set up, but also to modify. It was experienced that if automation is implemented with back-end methods and requirements change on the fly, costs can escalate.

However, in the literature, we can find contradicting viewpoints. On one hand, robotised processes are viewed as easily modifiable, flexible and quick to adapt, whereas modifications to traditional software are mentioned to require advanced IT skills - a view which is in line with the interviews (Willcocks, Lacity & Craig, 2015/06, p.8; Penttinen & Asatiani, 2016, p.2). On the other hand, it's also stated that only mature processes should be automated with RPA:

> *"Like shared services and outsourcing, RPA experts and early adopters report that RPA is most suitable for processes with high transaction volumes, high levels of standardization, are highly rules-based, and are mature."*
> *Lacity et al. (2015/04, p.9)*

In this case, I suggest we have to find the golden middle way: it is worth considering twice should a very unstable process be addressed by any means of automation. However, if automation could bring significant gains, but changes in the automation requirements are still likely, RPA can provide a very handy way of

implementing automation already before process is completely stabilised. Also Willcocks et al. (2015/05, p.24) recognise *"two fundamentally different ways of dealing with IT projects in the modern organization – 'specialist focused' and 'business/user focused' "*. They call two different approaches *Technical* and *Adaptive/Innovative*: adaptive approach goes with projects embodying business innovation, as they are inherently unstable. These projects present adaptive/innovative and not just technical challenges: detailed business requirements are unclear and can change quickly, and flexibility is therefore needed for further learning and innovation. I would classify RPA as solutions of these kinds of situations.

Stability of user interfaces

During this study, change management emerged as the biggest challenge of RPA. This is because software robots operate using existing system interfaces, and their configuration must be updated every time these interfaces change. As this can cancel out some RPA benefits, it was concluded that also stability of interfaces affects selection of automation approach.

This aspect has not been properly addressed in the existing literature. The only identified mention is that by Penttinen & Asatiani (2016): they conclude that criteria for RPA include *"Stable environment: Task is executed within predefined set of IT systems that remain same every time a task is performed"*. Even this notion doesn't identify user interfaces as the specific area where stability is required. Therefore, identifying user interface stability as factor affecting selection is new and potentially valuable finding – however, it should be validated in future research. In the future research, I suggest looking into RPA cases where system interfaces are regularly changing and observing the effect of this into long term costs and benefits of automation.

Interfaces between systems

Interfaces between systems, or in many cases lack of them, seems to be another central factor affecting selection. Informants perceived that if systems used in process to be automated had modern APIs, back-end automation was often relatively straightforward and a preferred approach. On the other hand, RPA enabled automating processes using systems where interfaces didn't exist and building them would have been costly or impossible due to old technologies, vendor lock in or dying system.

This finding was also in line with the existing literature. Barnett (2015) has recognised the exact the same factor:

> *"The fact that [RPA] can be used to create an API to a legacy application without requiring developers to perform major surgery means that RPA can be provide an interface to a legacy application that might be used by a BPM solution."*
> *Barnett (2015, p. 12)*

Also Penttinen & Asatiani (2016) wrote about flexible integration possibilities brought by RPA. They notify that with RPA, it is possible to integrate practically any software used by human workers. Software's openness to third party integration is not a determining factor, as RPA doesn't require changing the existing systems. As they remind, many corporate IT systems are proprietary and don't have public APIs: thus, RPA has a significant advantage compared to automation achieved through back-end integration (Penttinen & Asatiani, 2016). It can be concluded that interfaces between systems are one of the most important factors affecting selection of automation approach.

Time to market

Another identified factor was time to market: at FinBank Oy, it was even used as one of the main decision making criteria when comparing process development and automation approaches. Implementation timeframe is typically mentioned as one of the key differences between RPA and back-end automation: one of RPA's central value promises is delivering automation in a timespan of weeks rather than months, whereas back-end automation projects can in worst case take years.

> *" '[RPA has] been very fast when traditionally, we've been used to seeing nine to 18 month timescales for deployment as opposed to six to eight weeks.'*
> *– Kevin Mowles Head of Business Support, Leeds Building Society "*
> *Willcocks et al. (2015/05, p.19)*

This means that if automation is time critical, RPA can be a very efficient solution. Forrester Consulting (2011, p.4) recognised situations when it would be useful for business users to be able to create a "pontoon bridge" –solution themselves: that is, an automation solution that can be erected and taken down almost immediately. Situations where this

would be beneficial include for example sudden changes in business environment, when quick responses are required but lack of IT resources is slowing them down. The other example are situations when business users want to make simple extensions to existing applications (Forrester Consulting, 2011).

As recognised, the 2–4 weeks implementation time of RPA is short compared to enterprise software integration, which can take months or years *(Penttinen & Asatiani, 2016, p.2)*. In some cases, this enables first setting up automation can with RPA and later with other approaches: when discussing lightweight and heavyweight tools in general, Bygstad (2016, p.11) reports case from the healthcare sector where lightweight whiteboard solution was implemented without integrating it to the heavyweight systems upfront: only when use of the new solution was established, it was integrated to other systems. All in all, Willcocks et al. (2015/05, p.26) found RPA adoption decisions to be highly influenced by the speed of implementation and delivering business results.

Permanence of process

Permanence of process seemed to also affect companies' decisions. For long term automation implementations, back-end automation was regarded to often pay off despite its costlier and slower implementation. RPA was regarded to be clearly more temporary type of a solution. RPA was identified to be useful in the beginning and end of systems' life cycle, whereas back-end automation was seen to suit the middle of the life cycle, when the process is established and the transaction volumes are high. In the beginning of life cycles, RPA can enable prototyping or setting up new services quickly, and in the end of life cycle, it enables automating processes where back-end automation is no longer economical.

This finding was supported also by the original work about heavyweight and lightweight IT by Bygstad:

> *"Heavyweight IT should concentrate on the stable elements of digital infrastructures, such as basic registers and networks, security mechanisms and shared business components. This is the core of the heavyweight knowledge regime. -- Lightweight IT should provide the unstable and short-lived elements of the infrastructures: end-user interfaces, solutions for specific needs, Business Intelligence, RPA and similar solutions."*
> *Bygstad (2016, p.12)*

Willcocks et al. (2015/06 p.19) interviewed Blue Prism representative viewing that after RPA reaches so called 'institutionalised' stage in organisation, it can be used to test new business strategies quickly and cheaply. Also Bygstad perceives that development culture in lightweight IT is based on innovation and experimentation, which means that also solution life cycles can be short. Penttinen and Asatiani agreed that currently, RPA is usually a temporary solution filling the gap between manual processes and fully automated systems (Penttinen & Asatiani, 2016). All in all, based on both this study and existing research, it seems like RPA has a comparative advantage in solutions that must be set up agilely for a limited time. Back-end automation is more suitable for long term implementations.

IT resource situation

Lastly, IT resource situation was viewed to define selection of automation approach. As reported by Antero Immonen at FinBank:

> *"At least I can't tell a clear rule or criteria according to which [selection] would be made. It's affected by many things, like process maturity, number of exceptions, number of systems, and also the cold fact of resourcing situation at IT department or resource provider. Pretty often you face these 'then when' –systems, where the next version is already in development, and 'then when' it comes, we'll have this and that. But that 'then when' might have been going on for three years already. -- In a way, RPA is a quick way of doing things."*
> *Antero Immonen, FinBank, 30.3.2017*

To conclude, it was viewed that RPA can help to get system development done in a feasible time frame. The burden of IT departments is recognised also by multiple academics. Sommerville et al. (2012) recognise that heavyweight IT is overloaded in many organisations, which has resulted in long development backlogs. Process improvements are not typically IT's top priority: Willcocks et al. (2015/05, p.11) estimate that IT functions devote between 30-70% of their effort on maintaining legacy systems. In cases they observed, RPA was promoted because of huge IT development backlog and/or business problem, and was perceived to deliver quick wins and relieve pressure on IT (Willcocks et al. 2015/05, p.16, 20). Also Forrester Consulting (2011) interviewed companies that had

been able to address more process automation requests by allowing business users to self-serve. However, as mentioned earlier, I would treat this finding with some caution, as interviewees didn't regard RPA quite as business-user friendly as is sometimes claimed. Implementing and modifying RPA requires specialised capabilities, but after these capabilities are acquired, it can enable faster automation than IT departments could provide.

> *"The emerging truth is that in many cases RPA is a response to business problems that have been low on the long list of IT priorities, or which the IT function cannot deliver on quickly and cheaply enough, despite the business value."*
> *Willcocks et al. (2015/05, p.26)*

6 Conclusions

In this study, I searched to answer the following questions:

1) *How do companies choose between lightweight and heavyweight process automation?*
2) *What attributes affect suitability of these approaches?*

Theoretical background of the study was provided by Bygstad (2016), who views heavyweight and lightweight IT as two different knowledge regimes, which both respond to growing complexity of IT solutions. Central thing in the rise of lightweight IT is that innovation is increasingly conducted by non-IT professionals using easy-to-use and cheap solutions. In heavyweight IT, on the other hand, sophisticated solutions are produced by specialised IT staff, often to reduce complexity caused by silo systems by means of integration (Bygstad, 2016). Practical examples of these two approaches are Robotic Process Automation, which is emerging area of process automation, and back-end automation, which I define as *invasive automation, implemented by means of system development and/or data or application layer system integration*.

I approached the research questions by conducting expert interviews in Finnish companies operating in fields of telecommunications, banking, and IT services, accompanied by two case studies in 'Telco Oyj'. In these interviews and cases, I uncovered how companies select between RPA and back-end automation. As a result, I identified four high level decision making criteria, as well as eight heuristic factors that affect suitability of these approaches. The decision making criteria are *Business Case*, *Scope, Time to market* and *Anticipated development of system architecture*. The identified heuristic factors are:

- *Number of systems*
- *Process volume*
- *Changes anticipated in automation requirements*
- *Stability of user interfaces*
- *Interfaces between systems*
- *Time to market*
- *Permanence of process*

- *IT resource situation*

In addition to these factors, one more dimension was identified in the second case study: it should be considered *is process spanning over company borders*. It was observed that in cases when process crosses company boundaries, RPA can potentially reduce dependency on other parties involved in the process. This dimension has not been discussed in literature, and validating it requires further research.

The heuristic factors provide answer to research question number two. Moreover, by combining heuristics and decision making criteria, we can understand how companies choose between heavyweight and lightweight approach. All in all, it seems like companies do not proactively consider all factors that, in the end, affect their decisions: heuristic factors tended to appear in later phases of decision making, when one approach was investigated in more detail or when problems with chosen approach occurred. Stance of this study is that by recognising these factors and understanding how they affect suitability of different approaches, companies could make better informed decisions and achieve more sustainable automation benefits.

This study has both managerial and academic implications. Managerial implications follow directly from issues mentioned above. The academic implications, on the other hand, include novel insight about selection between heavyweight and lightweight automation. Based on this study, especially number of systems seems to be an important factor defining the selection. Moreover, some new factors not considered properly in existing literature were identified: these include changes anticipated in automation requirements, stability of user interfaces, and permanence of process. Also, importance of IT resource situation in determining suitability of RPA or back-end automation was questioned: this was because RPA was found not to be as business-user friendly as the current consensus seems to be. However, IT resources still undoubtedly have effect on choice of automation approach.

This study has certain limitations that should be considered. The chosen approach was comparing RPA and back-end automation, as they are representative examples of heavyweight and lightweight IT, and also interesting in the sense that they are fundamentally different by their level of invasiveness. However, this leaves big part of "traditional" automation approaches unaddressed: it must be remembered that not *all* automation apart from RPA is heavyweight and invasive. When applying results of this study, companies must understand what kind of automation they are comparing with RPA.

Also, labelling such a big part of different nuances of "traditional" automation under term *'back-end automation'* might not provide the most nuanced insights. Moreover, the findings are based on experiences and operating models of four companies only, and although they operate in different industries, findings about decision making are not completely generalizable.

Lastly, I provide some suggestions for further research. In future research, the factors identified in this study should be validated. Especially the hypothesis that RPA could reduce dependency on external parties when process crosses company boundaries requires further research. Also order of significance of identified factors should be looked into: observing what kind of relative weights the factors have in companies' decision making would provide more nuanced insight.

Once more, I wish to express my gratitude for interviewees in Telco Oyj, FinBank Oy, CGI and Digital Workforce for their invaluable input into this study.

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Appendix A: Information about companies interviewed for the study

Table A1: Information about companies interviewed for the study

Company	***Telco Oyj***	***FinBank Oy***	***CGI***	***Digital Workforce***
Description	Finnish tele-communications company	Finnish financial service group	World's fifth largest independent IT and business process services company	Only company in Nordics purely specializing in RPA services
Industry	Telco, ICT and digital services	Banking and finance	IT and business consulting and services	RPA services
Personnel	4 300	12 000	68 000	30
Operations in	Mainly Finland and Estonia, 11 countries in total	Finland	Americas, Europe and Asia Pacific	Finland and Sweden
Role of RPA	Used in operations	Used in operations	Provides consulting	Provides consulting

Figures used in the table are from 2016

Sources: Telco Oyj, FinBank Oy, CGI (2017), Digital Workforce (2017)

Appendix B: Coding scheme of the expert interviews

Table A2: Coding scheme of the expert interviews

THEME	CODE		n
Relationship of RPA and back-end automation	RPA one tool among others		11
	Complementing, not competing		9
	Coordination with IT stakeholders important		8
	Other tools		7
	What can be done with RPA could be done with back-end		4
	Same realities as in system development		4
	RPA requires well functioning base systems		3
RPA strengths	Processes using multiple (silo) systems		24
	Speed		12
	Cost efficiency		10
	Integrating closed systems		7
	Modifiable/ lighter to change		7
	For small volumes		5
	Addressing seasonal demand		3
	IT pipeline full		3
RPA challenges	Change management		17
	Not as easy as promised	Need for specific capabilities	11
		Same realities as in system development	4
	Access rights & security		10
	Limited performance		8
	Not for big volumes or system reforms		7
	Complexity of processes		6
	Existing environment limits		2
	Limits of chosen RPA platform		1
Typical RPA cases	Temporary	Developing new services	13
		End of life cycle systems	8
		Waiting for back-end solution	1
	Systems or business rules still changing		7
	Reports or checks to support expert work		5
	Input or retrieve data from silo systems		5
	Process crosses company borders		2
Decision making criteria	*Business case*		*8*
	Time to market		*5*
	Scope		*2*
	Number of systems used		24
	Process volumes		13
	Anticipated system or business rule changes		11
	Interfaces between systems		6
	Temporary or long term		22
	Resource situation (IT pipeline full)		1

Appendix C: Interview template, expert interviews

Following template contains themes covered in expert interviews. Template was modified for FinBank and RPA service providers

Background questions about interviewee and company

Could you tell briefly about yourself:
- Your position and responsibilities in Company X

Could you tell more about RPA operations of company X:
- How long have you been providing RPA services/using RPA in your operations?
- What kind of RPA projects/implementations have you done?

Questions about RPA

Based on your experience, what kind of strengths and weaknesses does RPA have? How do these strengths and weaknesses relate to those of back-end automation?

In your RPA projects/operations, have you encountered some recurring or surprising:
- Challenges?
- Advantages?
- Things that are not aligned with general consensus about RPA?

Questions about back-end automation

What other tools do you use for automating processes?
- What strengths do these tools have? What challenges?
- Could RPA help in addressing these challenges?

Questions about back-end automation vs. RPA

How do you view relationship of RPA and back-end automation?
- Can they address similar tasks? Or are they clearly suited for different profile of processes?
- Are they complementing or competing?
- Does RPA enable something that hasn't been possible with other tools? What?

How do you select between RPA and back-end automation?
- What factors do you consider?
- In what kind of situations is RPA (not) a suitable/possible solution?
- In what kind of situations is back-end automation (not) a suitable/possible solution?

Could you give an example of a case where selection was made between RPA and other automation tools?
- What kind of process was in question?
- What was the decision?

What were the factors affecting decision?

Could you give an example of a case where one of the approaches was already chosen, but turned out not to be suitable?

What problems occurred?

Why was the chosen approach not suitable?

Appendix D: Interview template, Telco Oyj cases

Following template was used mainly for the first round of interviews at Telco Oyj

Background questions for interviewee

Could you tell about:
- Your role in Telco Oyj
- About the unit/department/team you work in

Questions about the automated process

What was the process in question?

Can you describe the process (as it was conducted manually) in more detail?
- What were the concrete steps?
- What systems are used in the process?
- Who uses these systems? Who are involved in the process?
- What kind of process volumes? How many man years consumed?

Questions about RPA implementation

What gains were wanted out of RPA?

Who were involved in the process?
- Who was the partner?
- What parties from Telco Oyj were involved?

RPA Timeline
- When was RPA implementation done? How long did it take?
- What is the status now? What are the next steps?

Can you describe the process after implementing RPA?
- Describe the steps software robot conducts
- What exceptions were encountered?
- Is human involvement needed, where?

Questions about tool selection

What other automation approaches were considered?
- How were they explored?
- What were the findings?
- What challenges were identified with explored approaches?

To conclude, what were the reasons for selecting RPA?
- What were main factors affecting the decision?

Appendix E: Findings and citations from related literature

Table A3: Finginds and literature

High level decision making criteria		
Factor	**Description**	**Citations from literature**
Business case	Current manual costs versus costs of implementing and running automation	"The automation should be in sync with the business objectives and at the same time ensure quality and cost-effectiveness. The inclusion of automation techniques and machines may generally incur a high set-up cost or high initial capital. So many firms compromise quality of the products to setup a low cost or unnecessary automation which may not be the need of the business. So, it is a prime need that the business should be properly understood and also the exact requirement of the automation in the system should be analysed in depth." *(Mohapatra, 2009, p.7)* "RPA offers organizations the ability to automate processes that have been previously "out of reach" to more capital and investment intensive approaches to process automation." *Barnett (2015, p. 14)* According to Penttinen & Asatiani, criteria for RPA include "Clear understanding of the current manual costs: Company understands current cost structure of a task and is able to estimate difference in cost and calculate return on investment (ROI) of RPA. - - Business case outlines how the robots will automate the process and how robotic and other automation can be combined with the existing human resources to achieve cost efficiency and enhanced productivity." (Penttinen & Asatiani, 2016)
Scope	How big part of the process could be automated with each approach	See below

Anticipated development of system architecture	Changes anticipated in system architecture: system life cycles and updates	"The transformation should deal with the technically most suitable implementation and should also take care of future changes and roll-outs. The automation technique should take care of most of the business needs and processes it can cater to. However, there should be adequate facilities available to upgrade or replace the system with changing scenario and requirements of the business environment. The upgrades may include addition of add-ons or bringing in of specialist automation tools into the system." *(Mohapatra, 2009, p.7)*
Heuristics		
Factor	**Description**	**Citations from literature**
Number of systems	Number of systems used in the automated process	According to Penttinen & Asatiani, criteria for RPA include "Need to access multiple systems: Task involves accessing multiple systems. Example: copying data from a spreadsheet to a customer registry." *(Penttinen & Asatiani, 2016, p.3)* "RPA software is ideally suited to replace humans for so called 'swivel chair' processes; processes where humans take inputs from one set of systems (for example email), process those inputs using rules, and then enter the outputs into systems of record (for example Enterprise Resource Planning (ERP) systems)." *(Willcocks, Lacity & Craig, 2015/05, p.5)* "Xchanging has a huge amount of back office, high volume, repetitive data collection and processing tasks, many of them still manual, and many still taking data from non- integrated legacy mainframe systems. Moreover information is extracted from various sources e.g., Excel, Access, PDF, and input into another system or used to generate reports. - - Blue Prism RPA products seemed eminently suitable for addressing these issues." *(Willcocks, Lacity & Craig, 2015/06, p.9)*
Process volumes	Transaction volumes of the process	"Like shared services and outsourcing, RPA experts and early adopters report that RPA is most suitable for processes with high transaction volumes." *(Lacity, Willcocks & Craig, 2015/04, p.9)*

		"Telefónica O2 developed a simpler heuristic—a process is automatable provided automation can save at least three FTEs. Butterfield explained, 'There are a lot of processes that require less than half an FTE a month. And we're probably always going to keep those in Back Office because even though the commercials are very good for RPA, there's no point in automating a process that saves you less than three FTEs at the moment.' " (*Lacity, Willcocks & Craig, 2015/04, p.10)*
Changes in automation requirements	Changes anticipated in the process and thus requirements	"Third, processes automated via software robots are easily modifiable, even by the users of the system. Traditional software requires advanced coding skills to make any major modifications to the way it operates. On the other hand, software robots can be instructed through modifying relatively simple logical statements, screen capture of the process performed by a human, or even modifying graphical process charts. This makes RPA highly versatile and flexible." *(Penttinen & Asatiani, 2016, p.2)* *"'If you think about flexibility in something like robotics, that hits a sweet spot. A robot can scale up and down and switch tasks. You'll train an application, a bit of software once, and if your contracts change, a robot can be trained quickly to adapt.'* *— Paul Donaldson, Xchanging "* *(Willcocks, Lacity & Craig, 2015/06, p.8)* "Like shared services and outsourcing, RPA experts and early adopters report that RPA is most suitable for processes with high transaction volumes, high levels of standardization, are highly rules-based, and are mature." (*Lacity, Willcocks & Craig, 2015/04, p.9)* "Standardize and stabilize processes before automation: - - Applying automation to an unstable and/or inefficient process would not do that much good: *'This is a big one for us and which, I think, a lot of companies don't really understand. Don't automate a process that's not ready to be automated. Stabilise it first.'* *— Paul Donaldson, Xchanging "* *(Willcocks, Lacity & Craig, 2015/06, p.17)*

Stability of user interfaces	How frequently do the user interfaces of involved systems change	According to Penttinen & Asatiani, criteria for RPA include "Stable environment: Task is executed within predefined set of IT systems that remain same every time a task is performed" (Penttinen & Asatiani, 2016)
Interfaces between systems	Are there existing interfaces between the systems/ is building them possible	"The fact that it can be used to create an API to a legacy application without requiring developers to perform major surgery means that RPA can be provide an interface to a legacy application that might be used by a BPM solution." *Barnett (2015, p. 12)* "It is possible to integrate RPA with virtually any software used by a human worker, regardless of its openness to third party integration. Many corporate IT systems are proprietary with no public API's, which greatly limits their ability to communicate with any other systems. RPA solves this issue." *(Penttinen & Asatiani, 2016, p.2)*
Time to market	How quickly can the automation be implemented	"'What's needed is akin to a pontoon bridge — something that is erected almost immediately, can carry a tank across, and then [be] taken down just as quickly.' (Deputy head of change, UK retail bank)" *(Forrester Consulting, 2011, p.4)* "RPA can be implemented in a very short timeframe. Implementation time of 2–4 weeks is a blink of an eye compared to enterprise software integration, which can take months or even years." *(Penttinen & Asatiani, 2016, p.2)* "An illustrative example is the way the company Imatis worked in the Danish case; they started with implementing work process support in tight co-operation with the clinicians. Only after the whiteboards were supporting the processes in daily practice, they started to integrate the services with heavyweight technology. If they had started with integration, it is quite likely that the innovation process would have been slowed down and may even have halted. The project would also have faced a much larger initial cost, greatly increasing the risk of the initiative." *Bygstad (2016, p.11)*

Permanence of process	Is the process permanent or temporary	"Heavyweight IT should concentrate on the stable elements of digital infrastructures, such as basic registers and networks, security mechanisms and shared business components. This is the core of the heavyweight knowledge regime. -- Lightweight IT should provide the unstable and short-lived elements of the infrastructures: end-user interfaces, solutions for specific needs, Business Intelligence, RPA and similar solutions. For this division of labour to work, it is essential that the two knowledge regimes be loosely coupled." *Bygstad (2016, p.12)* "The (LW) development culture is innovation and experimentation; development cycles are short, and product life cycles may also be short." *Bygstad (2016)* "In the current state, RPA represents a temporary solution, which fills the gap between manual processes based on legacy IT systems and redesigned processes running on fully automated systems." (Penttinen & Asatiani, 2016) "Alex Bentley of Blue Prism also pointed out that, now that Xchanging has reached the 'institutionalized' stage, RPA could also be used to contribute to strengthening regulatory compliance, test out new business strategies cheaply and quickly, and address digital pain points in the organization. " *Willcocks, Lacity & Craig (2015/06 p.19)*
IT resource situation	Are IT resources available for implementing automation	"Heavyweight IT is currently overloaded in most organisations, with rising cost, long backlogs and increasing complexity." *(Sommerville et al., 2012)* "Behind the scenes, IT functions are devoting anything between 30-70% of their effort and cost on maintaining existing legacy systems." *(Willcocks, Lacity & Craig, 2015/05, p.11)* "In our case studies of success, RPA was touted invariably because of a business problem, and/or a huge backlog in IT developments/fixes required by the business." *(Willcocks, Lacity & Craig, 2015/05, p.16)*

		"For the IT department, first of all RPA can give quick, multiple business wins to their business customers, and simultaneously relieve pressure on the IT work backlog." *Willcocks, Lacity & Craig (2015/05 p.20)* "Forrester conducted in-depth interviews with 15 major organizations from a variety of industries, including healthcare, financial services, banking, telecommunications, and utilities. In all cases, these companies were able to deal with significantly more process automation requests than those using traditional IT or BPM approaches. They do this by allowing business users to self-serve, reusing their existing applications through desktop level integration rather than requiring the development and testing of lower-level integration components." (Forrester Consulting, 2011)